Copenhagen Business School

Autonomous Vehicles

A comparison of Google and Volvo and their use of internal resources in a dynamic environment

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M.Sc. Business Administration and Information Systems

Master's Thesis

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ABSTRACT

The car has since the invention of the assembly line developed into one of the most used forms of transportations in the world of today. Every day, millions of people get in their car to drive from one point to another. This is often a very time-consuming task, especially when commuting to and from workplaces as it often results in traffic jams and congestions. At the same time, hundreds of people are killed each day because of traffic accidents, while even more might be killed by the emission from the use of the cars. While the car industry has been adapting cars to be more modern through including more technology to ensure the safety of passengers and less emission, the idea of the car has not changed much since Ford introduced the first mass produced kind. It is still a human-driven transportation device. However, with the rise of computing power and machine learning, new opportunities have been sensed, by both traditional and untraditional players on the market.

Nearly all big traditional car manufacturers are currently working on an autonomous car, which will remove the human-driven aspect of a car. This trend was started by an unexpected entry to the market in 2009 when Google publicized its Google Car project. The intention of the autonomous cars currently in development is to reduce the time, accident-rate and emission of cars, by letting the car drive itself. This is done by using and analyzing live footage from radars, sensors, etc. to predict the car's next move.

Applying qualitative research methods, this paper collects secondary data from the Internet to analyze two business cases in the emerging market of autonomous cars. The business cases of Google and Volvo are analyzed using the theories of resource-based view and dynamic capabilities in order to indicate if any one of them has obtained competitive advantage in the new market.

The analysis shows that both business cases have obtained temporary competitive advantage, but are currently not able to obtain sustained competitive advantage. This is highly due to the inability of holding rare resources and seizing opportunities. Google has been good at sensing new opportunities, while Volvo has been better at seizing them.

Keywords: *Self-driving cars, autonomous cars, dynamic capabilities, resource-based view, sensing, seizing, transforming, valuable, rare, imperfectly imitable, non-substitutable, strategy*

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1 INTRODUCTION

We are living in a world where the technological impact on society is growing. This makes it even more important for companies to be innovative and explore new opportunities. The autonomous vehicle is a good example of such an opportunity, which has had a huge impact on the automotive industry and will in the future also impact customers.

1.1 Problem Definition

The automotive industry is an industry with constantly changing requirements and regulations. Especially in the last few decades, where technological improvements in other industries have influenced the way we depict cars. One of the latest and biggest changes is the introduction of autonomous vehicles. An autonomous vehicle is a car that is self-driven and is able to get from one location to another without any human interference. The introduction of autonomous vehicles took many car manufacturers by surprise. Therefore, it is interesting to look at the technology and how it is changing the automotive industry, as well as the single manufacturer.

In 2009, Google launched the first self-driving car project. That was a huge surprise, because Google is not known as a traditional car manufacturer (Google, a). Google is breaking into the automotive industry for two reasons: the autonomous car and access to big data (position based services). Google claimed, to be working on autonomous car technologies long time before deciding doing a self-driving car project. Therefore, it is interesting to study and analyze this business case (ibid.).

The car industry was taken by surprise when Google introduced their Google Car in 2009. Since then, nearly all manufacturers have launched similar projects. These projects differ in size and scale but ultimately have comparable goals. 'Concept 26' is Volvo's vision by 2020 of a self-driven car. Volvo's goal is to avoid deadly traffic accidents, by 2020 (Mertens, 2015). While Volvo and most, of the automotive industry, was rather surprised by Google's initiative, they have made huge progress, since. Volvo aims to have 100 prototype cars on the roads of Gothenburg by 2017. It is the largest autonomous car project in Europe right now (ibid.). Although, Volvo is a late mover, it is investing heavily to get these cars on the road. For that reason, Volvo becomes an interesting business case.

The car industry is rapidly changing, which makes it interesting to analyze the business cases based on the theories of dynamic capabilities and resource-based view. The theories can help companies seize opportunities and capture value. New opportunities come at a much faster pace in a rapidly changing environment. Competitors in all areas of the automotive industry are searching for opportunities and attempt to secure advantages, including Google. The company in the industry are alerted, and these theories can help in evaluating.

This point of view leads us to analyze the introduction of the autonomous car through the lens of this research question:

How do Google and Volvo use their internal resources to compete in the emerging market of autonomous car?

To analyze this research question, I will address the following sub-sections:

1. A review of academic literature for resource-based view and dynamic capabilities
2. Development of understanding of chosen business cases: Google and Volvo
3. Selection of theoretical concepts for analysis
4. Analysis of theoretical concepts by comparing the cases of Google and Volvo

1.2 Key Term Definition

Evaluating a large number of sources, both online and print, showed that many synonyms are used for the autonomous vehicle. Expressions like the self-driving car and autonomous car are the most used, but also robotic cars, smart cars, driverless cars and unmanned cars are used. Often the words car and vehicle are used interchangeable.

In this master thesis, the expressions autonomous car and the self-driving car will be used interchangeable. Gartner defines the self-driving car as *"one that can drive itself from a starting point to a predetermined destination in "autopilot" mode using various in-vehicle technologies and sensors, including adaptive cruise control, active steering (steer by wire), anti-lock braking systems (brake by wire), GPS navigation technology, lasers and radar"* (Autonomous vehicles.2016). This definition of a self-driving car will be used as working definition in this thesis.

1.3 Motivation and Objective

The phenomenon of the autonomous car is an interesting research topic because many car manufacturers are working on a car that is planned to be released in the near future. There are many reasons for working on such a car, described in further details in Chapter 2. The Gartner Hype Cycle for Emerging Technologies in 2015 (Appendix A), is also showing that the technology *autonomous vehicle* is at its highest level, ever (Gartner Newsroom, 2015). That supports further investigation into the topic in this thesis.

Motivation and idea for writing a master thesis about autonomous cars is based on previous courses where a citation states that: "*Creating autonomous cars is not easy. But in a world of plentiful accurate data, powerful sensors and massive storage capacity and processing power, it is possible. This is the world we live in now. It's one where computers improve so quickly that their capabilities pass from the realm of science fiction into the everyday world, not over the course of a human lifetime but in just a few years"*(Brynjolfsson & McAfee, 2012, p. 53). Brynjolsson & McAfee's statement shows that the technology of self-driving cars and all its elements are on the way up. Development will continue to get more perfection in development of the fully-autonomous car.

To analyze Google's and Volvo's reaction to the rapidly changing environment, the theories of dynamic capabilities and the resource-based view will be introduced as main theories for this master thesis. These theories relate to the rapid changing environment that competitors in autonomous car business have to be prepared for, while building capabilities to resist these changes and achieve competitive advantage.

1.4 Structure of Thesis

The below framework illustrates the structure of this thesis. First, Chapter 2 gives an *overview of the development of the car industry*. It includes the evolution of the car until the car of today and afterward looks at the car of the future: the self-driving car. Chapter 3 introduces the *theoretical foundations of resource-based view and dynamic capabilities*, together with the theories of the *business model canvas* and the *internet of things*. Academic literature is reviewed for these topics. Chapter 4 then presents the *methodology* that addresses the research philosophy for this thesis, the research design, research strategy, data collection, and lastly the data analysis. Chapter 5 covers the two selected *business cases* of Google Car and Volvo's self-driving car 'Concept 26', where the companies are described and an in-depth description of their self-driving car projects is provided. Chapter 6 presents the *case study analysis* were chosen concepts from resourced-based view and dynamic capability theory will be used to analyze the research question. Chapter 7 discusses the *findings* made in the analysis, and will also include a discussion of general topics within autonomous cars. Finally, Chapter 8 is the *conclusion* where the research question is answered with help from the analysis and discussion, a research limitation and further research section is included in this chapter.

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2 Overview of car industry

2.1 Historic Change in the Car Industry

The car industry has its roots back to the 19th century where it started in Europe. Mass production and standardized manufacturing made the cars interchangeable and synchronized. The best-known inventor of mass production was Henry T. Ford who produced the *Ford Model T* in 1908. The *Model T* was a success, but producing the car in large volume and at a low unit cost was a major challenge. The key innovation was the introduction of a moving assembly line. After a few failures the moving assembly line became reality in the 1920's, by more luxurious cars at the same low price.

By end of World War I, Ford and GM (General Motors) were the two world's largest automotive companies, competing with each other. At start of World War II in 1929, the U.S. car industry suffered by decreasing sales numbers. Between 1919 and 1939 brought growth in the European car industry, even if it was less than on the American market. The British automotive market was the fastest growing in Europe. In the 1920s, the French car industry began growing with three firms; Peugeot, Renault, and Citroën. When World War II began, many of the automotive plants were converted to produce tanks and other military equipment.

By the end of World War II, the U.S. car industry was decreasing and a new country, Japan, began to win market share first inland, and since 1980s in the rest of the world. The decades after World War II were characterized by diesel engines which were mostly used on trucks and buses and automatic transmissions were standard equipment for passenger cars. The German automobile industry was almost destroyed after World War II, but revival in the late 1950s to this industry. In the 1960s, the car industry focused on developing safer, with the first seat belt installed in 1964, vehicles met consumer needs.

The oil crisis began in the 1970s and forced the car industry to invent vehicles that were more fuel-efficient. After the 1980s, globalization had a great influence on the car industry. In 2008, fuel was so expensive that consumers began replacing big cars and buy smaller ones. For that reason, the hybrid, and gas-sipping engines were ruled out on many cars (Rae, 2016).

The pictures below show the transformation of the car from the 1900's till the Google Car of today.

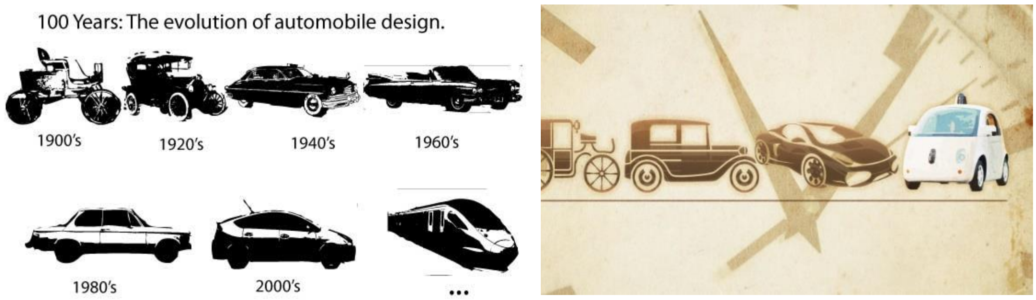

Figure 1: Evolution of the Car - Source: (127 years of modern automobile evolution. 2013; Infante, 2015)

2.2 The Car of Today

Looking at today's cars, a countless number of changes have been introduced throughout the many years of history in the car industry. The car of today is filled with features and new features are constantly coming.

Forbes Magazine writes that features like mini- and micro computers, positioning systems like GPS, sensors and cameras, help to go safely, fast, handle precisely and ride smoothly. These technologies are used to automatically set and control the speed, keep a safe distance to vehicles in front, and apply emergency braking to avoid a crash. Another feature is the built-in internet connect service, full smartphone integration and backseat high-definition video players to entertain children. Also, cars can park itself with help of computers, sensors and cameras (Gorzelany, 2015).

Car manufacturer Tesla rolled out an upgrade to the autopilot system (Model S), by download through internet service. The upgrade assists the driver by centering within the lane, speed control and automatically lane change by tapping the turn signal (ibid.).

BMW 7 series, has active driver assistant plus feature available. To maintain the car within the lane markers and to prevent the driver from changing lanes if another car is in the blind spot. Another feature which will be introduced in the BMW iDrive is a multimedia control system, where by hand gestures can control this system. Base technology are small infrared cameras on the dashboard. BMW 7 series will also offer remote pull, to park the car into a garage or a very narrow parking space and backing it out to the owner, again. Remote pull is still prohibited in the U.S. because of vehicular regulations (ibid.).

As drivers want more 'green cars', gas-efficient engines and motors become more important part of the today's cars. Smart GPS systems help to avoid traffic jams and find the fastest and most economical way. Sensors and cameras can assist the driver at night. For additional safety the systems will detect pedestrians, animals or other obstacles, which are typically invisible in the dark.

Parking assistants are included in many cars, today. These assistants help to park in tough spaces or parallel parking. Car makers like Volkswagen, Audi, Mercedes, Toyota, Lexus, Ford and Volvo offer parking assistants, but require the driver to be in the car. Bosch is working on a system where the driver can leave the car before the parking assistant is taking over (Padilla, 2015).

The flood of assistance systems and build in features are an indicator for strong competition between the automotive manufacturers. Smarter and more sophisticated features are announced, nonstop, trying to meet the customer needs and developing luxurious cars. Many of them will be found in autonomous cars, too.

2.3 The Car of the Future – Autonomous Cars

The car of today already includes many autonomous technology features, but the fully autonomous car goes a step further and includes even more technology. The first autonomous car was developed by the German engineer, Ernst Dickmanns in 1995. Dickmanns and his team incorporated several “transputers” into a car, the first man-made three-dimensional mobile vision system. They tested the car and it worked well and met expectations. But, Dickmanns’ car was ahead of time, the computing power needed to operate the car was too expensive and could not be used for commercial production (Adams, 2015). **Figure 2** shows all functions that an autonomous car need to have.

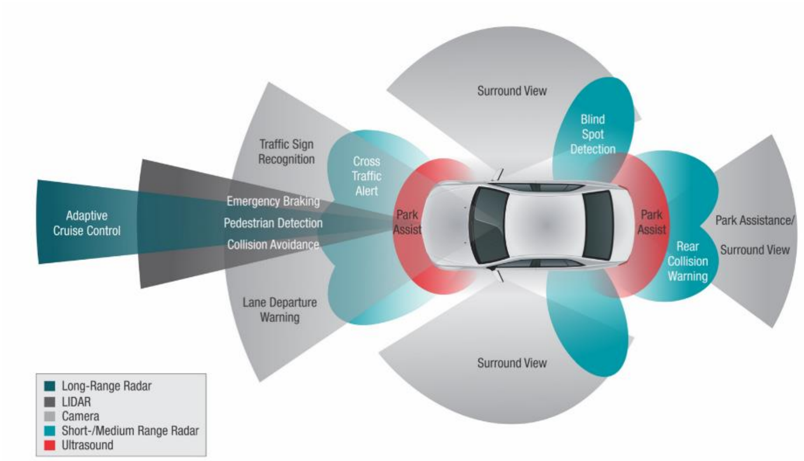

Figure 2 - Autonomous car functionality - Source: (Fassbender, 2013)

Many different companies are working on such cars e.g. Audi, BMW, Ford, GM, Google, Mercedes-Benz, Uber, Nissan, Apple, Tesla, Toyota, Volkswagen, Volvo and others (Hsu, 2015; Lensen, 2014).

To get an overview of how far the autonomous car is to be published, Appendix B show the evolution of it and when it should be ready for public roads. Within this evolution, different levels of autonomous driving are available. These different levels are shown in Appendix C and will now be explained. It is important to understand that it will need some time before fully autonomous cars operate on open road. Level 1 to 4 have to be handled both legally and by the car manufacturers, before. According to IHS the different levels are explained as below (Dorrier, 2014).

Level 1: This includes driver initiated systems where a safe distance is kept and the car also keeps the car inside the lane while using cruise control. Also included feature here are self-parking and automatic emergency braking.

Level 2: Here the computer controls functions like gas, brakes, and steering in traffic jams. Laws requires that the driver keeps the hands on the steering wheel.

Level 3: At this level full automation in certain situations is possible. Here the driver will not be required to keep an eye on the street all time, but the car will drive. The car will give the driver time to reassume control when it is required.

Level 4: It will still be possible to give the control to the human driver, but else the car is full automated and self-driving.

Level 5: There is no driver anymore. The car will not allow humans to take control of the car, and steering wheel and pedals will not be included in the car.

At the moment level 1 is on its way to be legally regulated in Germany. Fully autonomous driving is something which is further out than around 2020. Without legal regulation it will be impossible for automotive manufacturers to sell autonomous cars (Lensen, 2014).

IHS also believes that level 4 and 5 cars will be on the road between 2025 and 2030 and that in 2050 most cars will be autonomous operated (Dorrier, 2014).

KPMG believe that two types of technologies need to converge before self-driving cars can become a reality. These are the sensor-based solutions and also the connected-vehicle communication. 2025 is the year where self-driving cars could be driving on the streets (KPMG, 2016).

2.3.1 Benefits for Developing Autonomous Cars

There are different opinions about the motivation for developing autonomous cars. Adam Ozimek asks the question: "*Why would self-driving cars even be a big deal?",* and answers the question in a Forbes magazine article by coming up with considerable facts. Ozimek writes that it can save lives, it can give the driver more time for other things than driving the car e.g. to let the driver spend time on napping, reading or something else, senior citizens can be driven around, even people without a driver license can be driven around, cost savings for households, as they can get cheaper access to a car by not owning but renting or sharing. The time-saving aspect can also be counted on to numbers that will save the society for a lot of money. In the U.S. there were about 30,000 fatal car crashes in 2013 if these could be prevented, a yearly benefit of $276 billion could be reached (NHTSA, 2014; Ozimek, 2014).

Another motivation to develop autonomous cars is smaller delays, less pollution and better driver and passenger comfort (Gerla, Pau, Lee, & Lee, 2014). Litman (2015) also argues that benefits like reduced driver costs which mean fewer costs for the use of taxis and public transport. In bigger cities where parking spots are a scarce resource, the benefits of having self-driving cars can help solve this issue too.

2.3.2 Problems with Developing Autonomous Cars

Looking at the associated costs of autonomous cars for a whole economy like Germany or whole EU it is not easy. Multiple investments have to be saddled e.g. invest in roadway, parking or traffic infrastructure, as well as ongoing cost e.g. traffic routing. It will also have an impact on employment of mechanics and replacement parts for the car, because of fewer accidents. With economic impact on this industry. Key problem for car manufacturers are missing legal regulations for autonomous cars. Without legal basement, autonomous cars will not have access to the mass market, but will stay restricted for test usage The predicted time frame for having self-driving cars legalized is between 2015 and 2025 (Litman, 2015).

2.3.3 Technology in Autonomous Car

Many technologies which are found in the car of today e.g. self-parking assistant, automatic emergency braking, adaptive cruise control and lane-keeping assistant will also be used in autonomous cars, too. The development and integration of technologies have left the car from going from the driver driving the car to assisted driving and in the future fully autonomous driving (The self-driving car.2014).

Going on to look at the different technologies that are used in autonomous cars, they consists of lasers, radars, cameras that can detect objects in all directions and computers for self-driving cars. The on-board computer uses maps and online-traffic messages to prevent incidents or jams. The maps have to be of high accuracy and resolution. Providers like TomTom and Bosch and also Here

(Schuldt, Plöger, & Wiesmüller, 2015) are working on these high-resolution maps for autonomous cars.

Various highways are used to test different technologies. E.g. in Sweden, Volvo's 'Drive Me' project will use some test roads in Gothenburg. In the U.S., Nevada is a state where many car manufacturers are started to test their cars, including Google (Wiesmüller, 2016).

The integrated cameras can recognize outlines and color differences, but the backlit from outside and other cars makes the cameras less precise. Even high accurate measurement of the car's speed is a challenge, today. Radar sensors are good at measuring speed differences and distances. With the challenge to differentiate between multiple moving objects. Laser scanners are expensive, but handle both rain, fog and other weaknesses. A triple camera may solve the problem, but will first be availbale in 2018.

As mentioned earlier, another important technology are the high-resolution digital map to allow car navigaation systems to allocate the cars position fast and accurate. These maps or navigation systems need an accuracy of 20 centimeters for an autonomous car. As navigation systems today only have an accuracy of 5-10 meters, this is not enough. Car manufacturers need more precise systems. This could be done by using the already implemented sensors that are placed in the car. These sensors can help with identifying objects around the car while driving. All the data that is collected through this process will create a map which can be used for further driving. Experts say that Google is in front in the creation of a map that can be used by their autonomous car, and also the algorithms within this map. Over time the car is learning by the many different situations it will be part of and use this information for future actions.

To use all these technologies a massive, wireless, high bandwith and low cost exchange of data is mandatory today e.g. UMTS 4G. At the moment, this technology is not fast enough or at least not fast enough to let the autonomous car react fast on unpredictable events (Auto Motor und Sport, 2016).

3 Theoretical Foundation of Resource-Based View and Dynamic Capabilities

3.1 Literature Review – search process

The purpose of a literature review is to identify the state of knowledge on the topic of interest, to identify key authors, articles, theories and findings in that area and also to identify any gaps in the knowledge in that research area. To write a literature review, keywords and online databases are used. Different search techniques can be used. When relevant and interesting articles are identified, the reading can start. To narrow down the number of articles, the abstract can be read to find out if the particular article is within the defined scope. It is important to cover the whole area to have a complete overview, therefore, restrictions to a few journals, a few years, or specific methodology are not recommended. The reviewed articles should be summarized and a concept matrix should be prepared which will be used in the analysis. A well-conducted literature review should indicate whether the research question has already been addressed in the literature and if the initial research question should be modified because of the findings of the literature review (Bhattacherjee, 2012).

Search Process for Master Thesis

To get a broad overview and a good understanding of the academic literature on dynamic capabilities and resource-based view, I first used the method of an unstructured literature search. Different online databases were used for this purpose, e.g. Google Scholar, Scopus, Business Source Complete and ACM Digital Library. I only used the delimitations for getting English language articles and also tried to delimitate for peer-review articles. Many keywords were used for the search and the composition of them was manifold. The range of terms that were included were terms such as dynamic capabilities; resource-based view; RBV; resource based view; selfdriving cars; self-driving cars; autonomous cars; autonomous vehicles; driverless cars; robot car; robotic cars. The combination of exactly these keywords is reasoned by that I want to figure out if my research question has been researched before. This combination gave me no results I could use. Therefore, I focused on only searching for articles within my chosen theory, which gave me results that I could use. This was extended with a search by including information technology and information systems to these theoretical terms.

The keywords dynamic capabilities and resource-based view should either be in their keywords, title, or abstract and written together, which was indicated by using "".

Talking to my supervisor gave me the inspiration to look at (Katkalo, Pitelis, & Teece, 2010) as a starting point for the theory of dynamic capabilities. I started reading this paper, and at the same time the search on the databases was going on.

I used the method of pen and paper to write down the key points in the article of (Katkalo et al., 2010) and mark the concepts which could be useful in my later analysis. This method was used for the further search and readings too.

Also, I looked at the reference list to find articles which could be relevant to use for my literature review. These articles were then found, and the abstract was read. In my database search, I ended up having about 25 articles which could be relevant for the dynamic capability theory and about 15 articles for the RBV theory. These papers were then briefly assessed based on the abstract. In the whole search process, I ended up having 15 research papers I used as a foundation for my literature review. Nine ‘key papers’ were identified within the dynamic capability area (Barreto, 2010; Eisenhardt & Martin, 2000; Helfat et al., 2009; Helfat & Martin, 2015; Katkalo et al., 2010; Teece, Pisano, & Shuen, 1997; Teece, 2007; Teece, 2010b; Teece, 2011) and six within the resource-based view area (Armstrong & Shimizu, 2007; Eisenhardt & Martin, 2000; Katkalo et al., 2010; Liang, You, & Liu, 2010; Spender, Kraaijenbrink, & Groen, 2010; Wernerfelt, 1984).

The first paper I started to read through was the one of (Eisenhardt & Martin, 2000) based on the title and content of the abstract, as it covered both the topic of dynamic capabilities and resource-based view. Other articles were found from the papers read in previous courses within these theories (Rindova & Kotha, 2001; Teece et al., 1997; Zollo & Winter, 2002). Reading through the abstract gave the impression of relevance to this research, which makes some of them also listed in the above list of ‘key papers’.

The listed papers indicated that David J. Teece is a key author in the area of dynamic capabilities. The search for new papers stopped when I started to turn back to articles which I already had found before. This made me stop looking for more and instead start to focus on the found papers and start to look into them, and in that way find concepts for the analysis, but also to look at if my research question has been addressed in the literature. Closest to my chosen topic within these papers is the general focus on the organizational and technological perspective. But most papers were in the research area of strategic management. Therefore, I started to use another technique to find papers that were within the area of information systems and/or information technology. For this I used Scopus, here I could look up a chosen article and from that point look at related documents and 'cited by' documents. This gave me results within the field of information systems/technology in relation to dynamic capabilities and/or resource-based view. These articles (Bharadwaj, 2000; Dehning & Stratopoulos, 2003; Drnevich & Croson, 2013; El Shafeey & Trott, 2014; K. Huang, Wu, Dyerson, & Chen, 2012; S. Huang, Ou, Chen, & Lin, 2006; Luo & Bu, 2016; Parida, Oghazi, & Cedergren, 2016; Ray, Barney, & Muhanna, 2004) are also used in the literature review.

3.2 Resource-Based View in Literature

The most well-known and recognized research paper within the field of the resource-based view appeared in the 1980's and is written by Birger Wernerfelt (1984). Wernerfelt (1984) argued that it could be important to look at a company's resources rather than their products. The purpose of writing this paper was to develop an economic tool that could be used for an analysis of a firm's resource position and which strategies could be used to perform better. This strategy could balance the exploitation of existing resources and the development of new ones.

Another perspective of the resource-based view can be drawn from the IT perspective where an analysis of IT effect on the performance of a firm can be executed. Here the company performance can be related to the company's resources that are firm-specific, rare, difficult to imitate and difficult to substitute (Bharadwaj, 2000). Bharadwaj (2000) argue that investments in IT can be duplicated by rivals, therefore, those cannot provide a competitive advantage. Therefore, it is important for firms to know how they can leverage their investments that will create unique IT resources and skills and this will show the company's overall effectiveness.

Resource-based view states that companies depict from a collection of capabilities and resources and that these are required for market and product competition (Parida et al., 2016). This collection of capabilities and resources is different from company to company. Some companies are better at using the collection to implement strategies that others find costly to implement. The differences in resources and capabilities can also be long lasting and therefore a source of sustained competitive advantage (ibid.).

Resources are the main concept of the resource-based view. Resources can be specified as specific physical, human and organizational assets that are used to implement value creating strategies (Eisenhardt & Martin, 2000). Another characteristic of resources is that they have to be renewed constantly, as resources are indicated as stock. This logic of renewing resources is amplified in fast moving environments like in the high-tech sector (Katkalo et al., 2010).

Huang et al. (2006) categorize resources into tangible, intangible and personnel-based resources and explains that these resources can be used by companies to achieve competitive advantage. This competitive advantage can be created by assembling all three categories of resources and if the assembled resources can work together, organizational capabilities and IT capabilities are build.

Many companies have a corporate strategy that focuses on IT and is therefore called an IT-enabled strategy. This strategy supports economic activities that are performed. When companies implement such a strategy it is possible for them to gain a competitive advantage over their competitors (Parida et al., 2016). The research made by Parida et al. (2016) indicated that companies that have superior managerial IT skills are better at sustaining an IT-enabled competitive advantage.

The use of information technology in a company can help to increase the opportunities to create a maximum value by using knowledge. This knowledge can help to inform the company about IT investments and its implementation. Costs and benefits are therefore important to evaluate for such an investment (S. Huang et al., 2006).

The resource-based view also argues how competitive advantage within companies is achieved and how it might be sustained over time (Eisenhardt & Martin, 2000). Liang et al. (2010); Spender et al. (2010); Armstrong et al. (2007) and Bharadwaj (2000) argues that organizational unique resources that can create competitive advantage need to acquire and control the following attributes:

Valuable (V)	The resource can enable a firm to conceive or implement strategies that improve its efficiency or effectiveness.
Rare (R)	The valuable resource should not be possessed by a large number of competing firms.
Imperfectly imitable (I)	The valuable resource should not be easily imitated.
Non-substitutable (N)	The valuable resource should not be easily replaced by other substitutes.

Table 1: Resource attributes to create sustained competitive advantage - Source: (Liang et al., 2010, p. 1140)

El Shafeey & Trott (2014) add that valuable resources also have an effect on exploiting environmental opportunities or neutralizing threats. The rarity of a resource can be obtained when competitors cannot perceive the resources value by the firm’s specific resource combination. When a resource is imperfectly imitable it makes it difficult for competitors without this resource and they can face disadvantages in the acquisition or development of this resource. If companies cannot imitate the valuable and rare resource it is not possible to have the same strategy because they cannot use different resources. When a firm exploits these four resources when also implementing a value creating strategy this will create more value for the company than for its competitors.

It is suggested that business processes that exploit valuable resources only can be a source of competitive parity, where temporary competitive advantage is explained by when business processes exploit both valuable and rare resources, and when business processes exploit both valuable, rare and imperfectly imitable then it achieves sustained competitive advantage (Ray et al., 2004). Ray et al. (2014) add to this, that if firms want to realize the full competitive potential of their resources and capabilities then a firm have to organize its business processes efficiently and effectively.

Spender et al. (2010) also state that a company has achieved competitive advantage when a value creating strategy is implemented and this strategy is not implemented by any other current competitor. Armstrong & Shimizu (2007) add that competitive advantage is achieved when a firm can produce more economically and thereby better satisfy customer needs, which leads to better performance relative to their competitors.

Liang et al. (2010) argues that IT is a valuable organizational resource and that resources can enhance organizational capabilities which can lead to higher performance. This higher performance is determined by the resources that a company owns.

The rapid improvement of information technology the recent years have affected most emerging economies. This development has shaped human life and is also creating new ways for businesses to operate and manage (Luo & Bu, 2016). Luo & Bu (2016) states that prior studies have been looking at information technology through a resource-based view, where firms do and can differentiate their information technology resources. This can create firm-specific capabilities which can contribute to sustained competitive advantage. It is also argued that there is little information about the importance and how valuable information technology is for emerging economy companies, this is a gap that requires more research. Those kind of companies are often competing in an interconnected and knowledge-intensive global marketplace, where data and information are available in overflow and this makes strategic business decisions difficult. When companies have a properly designed and implemented information technology strategy, this enables effective information and knowledge flow. Information technology makes it possible for companies to benefit from competitors by learning through the access of up-to-date information and knowledge (ibid.).

Dehning & Stratopoulos (2003) state that the competitive advantage that has been granted by information technology has a short life because computer-based information systems can easily be replicated by other firms by copying and improving the information technology that is used. But it is also argued that IT-enabled strategies can help the company achieve sustainable competitive advantage.

El Shafeey & Trott (2014) criticize that the valuable, rare and imperfectly imitable resource framework as a testable theory has the problem of epistemological impossibility problem. This problem says that the framework does not allow reproducibility, falsifiability, and generalizability. The reproducibility problem means that the research for competitive advantage in a firm, together with the unique resources, is almost impossible to reproduce in another firm or context. This can also be related to the generalization problem where a company's competitive success often is a result of the heterogeneous endowment of resources, which exclude the execution of confirming experiments of other firms. It is also argued that it is always possible to identify a heterogeneous resource, which can be described as the single source of a company's success. This, together with the difficulty of recreating the same experiments in other companies, makes it impossible to actually reject the proposition that certain kinds of resources are the single source of a company's success.

Ray et al. (2004) argues that "*firms can have competitive advantage in some business activities and competitive disadvantage in others"* (p. 24) and continues to state that "*[…] resources, by themselves, cannot be a source of competitive advantage. That is, resources can only be a source of competitive advantage if they are used to 'do something' i.e. if those resources are exploited through business processes"* (p. 25-26).

In some situations, the resource-based view cannot explain how and why some companies have obtained a competitive advantage in situations where there are rapid and unpredictable changes. In markets where the competitive environment is shifting, the dynamic capabilities become the source of sustained competitive advantage (Eisenhardt & Martin, 2000).

3.2.1 Contextualization of Theoretical Concepts in RBV related to the Car Industry

To contextualize the theoretical concepts within resource-based view, examples will be provided of where they can be found in the car industry, the information used is mostly coming from the first chapter *Introduction* and second chapter *Overview of the car industry* and *business cases*.

To achieve competitive advantage, the VRIN attributes have to be acquired and controlled, looking at the first attribute *valuable,* this can be seen in the invention by Henry Ford who invented the moving assembly line as a valuable resource in the beginning of the 20th century (Rae, 2016). By the invention of the moving assembly line, Ford could have a more effective production and this was an important strategy for Ford, which is also compatible with some of the other attributes.

The *rare* attribute can also be seen within the moving assembly line, as competitors to Ford did not possess the same technology, this was first an option for the competitors at a later point.

The third attribute that has to be acquired and controlled is the *imperfectly imitable resource*. This resource can again be seen in relation to the moving assembly line as the effort for others to build the same and have the same technology was a huge investment, and each part of the assembly line had to be fitted to the companies' requirements for their own cars. Another place to use this attribute is the self-driving car, where the technology is difficult to imitate as it is expensive, and each company working on a self-driving car have its own way for building and developing these cars.

The last attribute, *non-substitutable,* can also be found within the moving assembly line as it is difficult to replace it by other substitutes. The method of the moving assembly line is still used in many car manufacturing sites today. If it should be replaced, a new technology and new way of assembling and building the car should be invented which should be even more effective. A possible substitute could be the customization of cars.

3.3 Dynamic Capabilities in Literature

Looking into academic articles for dynamic capabilities in innovation-based environments, it is visible that David J. Teece has had a big influence on this topic and written many papers. The paper from 1997 by Teece et al. is known as a landmark article and have since contributed to a flow of research papers focusing on strategic management (Barreto, 2010). Teece states that "*dynamic capabilities are firm's capacities to integrate, build, and reconfigure internal and external resources to address and shape rapidly changing business environments"* (Teece, 2010b, p. 692). This definition is also used in other papers (Katkalo et al., 2010) and has also been modified to different fields of research. Another explanation of dynamic capabilities is made by Eisenhardt & Martin (2010), they argue that dynamic capabilities are "*the firm's processes that use resources – specifically the process to integrate, reconfigure, gain and release by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die" (p. 1107).*

Teece (2007) provides the ambition for the dynamic capability framework by arguing that it is *"nothing less than to explain the sources of enterprise-level competitive advantage over time, and provide guidance to managers for avoiding the zero profit condition that results when homogeneous firms compete in perfectly competitive markets"* (p. 1320).

Capabilities can either be dynamic or static (Katkalo et al., 2010). Furthermore, Helfat & Martin (2015) explain capabilities as *"the capacity to perform a particular activity in a reliable and at least minimally satisfactory manner" (p. 1285).* Another explanation of capabilities is provided by Parida et al. (2016) who argues that capabilities are the company's ability to combine resources and add that capabilities are non-transferable, firm-specific resources which can improve the productivity of other resources that are possessed by the company. Dynamic capabilities are seen as necessary conditions for obtaining a competitive advantage. Examples of dynamic capabilities could be the product development process or knowledge creation process (Eisenhardt & Martin, 2000). Bharadwaj (2000) argues that companies can create competitive advantage by assembling the firm's resources that can work together and thereby will create organizational capabilities. Teece (2007) state that sustainable competitive advantage can only be obtained in fast moving business environment by not only having ownership of difficult-to-replicate resources e.g. knowledge, but also unique and difficult-to-replicate dynamic capabilities.

Drnevich & Croson (2013) calls dynamic capabilities a flexibility-based theory and explains it as the ability to quickly respond to changes in the firm's environment where either efficiency or effectiveness is improved. The quick responding can improve efficiency by minimizing the costs of adapting to a new situation e.g. reducing the total costs of creating a new product. The improvement of effectiveness can happen by seizing an opportunity for more profit e.g. increasing producer surplus with the creation or improvement of a product, which then will increase customer value. Flexibility can give a company value-creating opportunities, especially IT can give a flexible company the opportunity to exploit opportunities, but also avoid threats from a competitor.

Dehning & Stratopoulos (2003) state that firms more and more realize that they can sustain IT innovation and business success by developing superior IT capabilities.

Helfat et al. (2009) say that *"Strategy matters most during times of change […]. As markets become more globally integrated and new forms of technology and competition arise, companies cannot rest on their laurels. Firms must adapt to and exploit changes in their business environment, while seeking opportunities to create change through technological, organizational, or strategic* *innovation. […]. To survive and prosper under conditions of change, firms must develop dynamic capabilities to create, extend, and modify the way in which they make their living" (p. 1).*

The definition mentions dynamic and changing environments such as markets. A *dynamic market* is defined as a market where change occurs frequently, but also along predictable and linear paths. In dynamic markets, the competitors and customers are well known for the company, which makes it even more important to use existing knowledge and thereby have effective dynamic capabilities. Repeated use of best practices is an important learning skill to develop dynamic capabilities (Eisenhardt & Martin, 2000; Teece et al., 1997).

Huang, Wu, Dyerson & Chen (2012) say that if companies in fast changing markets want competitive advantage over a longer period of time, then firms must nurture the ability to innovate. Huang et al. (2012) also state that *"Dynamic capabilities, in explaining how firms integrate internal resources to cope with fast changing environments, help us to answer how technological firms facing uncertain technological and market environments can sustain competitive advantage"* (p. 644). It is also argued that winners on a global marketplace need to be very innovative and flexible companies with high responsiveness and rapid product and service development, combined with efficient management capabilities to coordinate and redeploy external and internal competences. Technological competences is key for the company's capability of innovation. These technological competences can exploit and explore technological opportunities in the rapid changing environment, this will increase a firm's competitive advantage (ibid.).

Companies operate in mutable and dynamic changing environments, characterized e.g. by changing customer needs, intense competition, increased flexibility, and demand for new products. This makes dynamic capabilities important as firms can reconfigure resources and reuse technical building blocks to survive under dynamic environmental conditions. The capabilities in such environment are established to be critical, as firms without these capabilities will not achieve competitive advantage now or in the future (Parida et al., 2016). Four sub-capabilities are identified in the paper of Parida et al. (2016), where the first one is an absorptive capability, the next an adaptive capability, the third an innovation capability and the last one is the network capability. When firms have absorptive capabilities it enables them to identify and utilize knowledge for commercial purposes from external parties. The adaptive capability gives a firm the ability to identify and capitalize opportunities quickly on emerging markets. If the firm has adaptive capabilities it will be able to meet the changes in the environment, this can be done by aligning the firm's internal resources, and thereby exhibiting dynamic capabilities. An innovative capability gives a firm the opportunity to develop new products or processes. This is done by combining corporate strategy and innovation. Innovative capabilities are most important for smaller companies operating in a dynamic environment and gives them the opportunity to effectively sustain their competitive advantage in rapid changing environment. Last but not least the network capability gives the company the possibility to develop and utilize inter-organizational relationships that make it possible to obtain access to resources or technologies held by other companies or institutions. When companies have some or all of the four capabilities they can mitigate the challenges that are related to environmental changes and thereby achieve competitive advantage. The research on these sub-capabilities is not finished yet, as the question of how these capabilities are developed is still not sufficient answered, yet.

Companies possess the opportunity to enable capabilities to evolve and co-evolve with the rapid changing business environment by the concepts of *sensing, seizing and transforming*. These concepts are also very important to the company's long-term profitability. Dynamic capabilities support one or more of these concepts (Katkalo et al., 2010). Teece (2011) also argues that *"these activities are required if the firm is to sustain itself as markets and technologies change, although some firms will be stronger than others in performing some or all of these tasks"*.

Sensing is the identification and assessment of new opportunities both within and beyond prevailing technology. When markets evolve, a company's consumer needs, competitive positioning and product technologies change which can threaten the existing position in the market, but on the positive side, it can open up for the possibility of a new and better position (Teece, 2010b).

Seizing is the mobilization of resources that address the opportunity and capture the value from doing so. This can require investments in development to new products, processes, or services. A new competence can be built to obtain the development that is needed (Teece, 2010b). These seizing capabilities are also used for designing business models that satisfy customer needs and thereby can capture value (Teece, 2011).

Transformation is related to the continued renewal. Having continual transformation helps with creating and capturing value. The efforts made at sensing and seizing can help delineate a way for value creation, but the firm is still required to consider the 'fit' to the opportunities the company plans to exploit. It is further important that the management assesses to the coherence of the firm's business model in relation to the business environment (Teece, 2010b).

	Sensing	**Seizing**	**Transforming**
Value creation	- *Spotting opportunities* - *Identifying opportunities for R&D* - *Conceptualizing new customer needs and new business models*	- *Investment discipline* - *Commitment to R&D* - *Building competencies* - *Achieving new combinations*	- *Achieving recombination's*
Value capturing	- *Positioning for first mover and other advantages* - *Determining desirable entry timing*	- *Intellectual property qualification and enforcement* - *Implementing business models* - *Leveraging complementary assets* - *Investments or co-invest in production facilities*	- *Managing threats* - *Honing business models* - *Developing new complements*

Table 2: Activities to create and capture value (dynamic capabilities) Source: (Katkalo et al., 2010, p. 1180)

Another way of looking at sensing, seizing and transforming, is through the lenses of micro foundations (Teece, 2007). Teece (2007) explains that new research on dynamic capabilities have acknowledged a panoply of routines and processes that can be documented as providing microfoundations for dynamic capabilities. These microfoundations can for instance be cross-functional research and development teams, new product development routines, and quality control routines, which all are elements of dynamic capabilities.

Each phase; sensing, seizing and managing threats and reconfiguration (transforming) are also part of his perspective, but each phase have micro foundations (elements), that differs in some degree from Table 2.

The microfoundations of sensing include: processes to direct internal R&D and select new technologies, processes to tap supplier and complementor innovation, processes to tap developments in exogenous science and technology, and processes to identify target market segments, changing customer needs, and customer innovation (Teece, 2007, pp. 1323-1326). The elements that are important for seizing are: delineating the customer solution and the business model, selecting enterprise boundaries to manage complements and "control" platforms, building loyalty and commitment, and lastly selecting decision-making protocols (ibid. pp. 1329-1334). Microfoundations for the phase of managing threats and reconfiguring are: decentralization and near decomposability, co-specialization, knowledge management, and governance (ibid. pp. 1336-1340).

3.4 Internet of Things

The technologies of sensors, lasers, radars and self-driving communication technology can be related to Internet of Things or in this case the Internet of Autonomous Vehicles (Gerla et al., 2014). Gerla et al. (2014) state that the Internet of Vehicles will make it capable for car's to make independent decisions about driving the passengers to their destination. The Internet of Vehicles will include e.g. communications, storage, intelligence and learning capabilities, which will help to anticipate the requirements and wishes the customer may have. The service that is needed to make the autonomous car become a reality is the Vehicular Cloud, which will provide the car with all services needed. The autonomous car produces mass data which is used by the car itself and other vehicles near by, to drive as precise and safely as possible. Up-to-date information and accurate data is very important both for the car itself, but also to and from the cars near by, as the autonomous car is traveling fast with short distance. Collaboration between autonomous cars will be a strong asset, as accurate, real time information can be shared and processed and updated in between and among multiple clouds of cars or data pools (Gerla et al., 2014).

For a better understanding of the Internet of Things, an explanation by (Mishler, 2015) can be used: *"the interconnectivity of a variety of remote devices via the Internet or internal networks that provide real-time information for analysis and decision making" (p. 62).*

This explanation helps us to understand that self-driving car's will become ubiquitous and will be part of a huge network connected with other cars. The network will provide real-time information to the car itself, but also to other cars and to again correct decisions. This is called vehicle-to-vehicle and vehicle-to-infrastructure communication.

3.5 Business Model Canvas

The business model is an important part of the concepts within dynamic capability theory, because sensing, seizing and transforming are divided into value creation and value capturing. Therefore, a short explanation of the business model will be given, as it is part of the analysis in Chapter 6.

The business model describes the design and architecture of the value creation, delivery, and value capture. It is important to be more customer-centric, as the business model shows where profit is generated. For companies, it is important to know how the value of new products should be captured (Teece, 2010a). Google and Volvo are innovating new products by the self-driving car, and if they want to capture value from that, they need a business model that fits. Without delivering value to customers, most new product will fail, therefore, the different parts of the business model have to be considered carefully. Serious competitive advantage can only be accomplished if the business model is difficult to imitate for others and the business model is on regular review for change and innovation. The most important component of a business model is the value proposition that is compelling to customers. Especially in a competitive environment this is important because the consumer wants constant invention (ibid.).

Some companies find it difficult to become digital and also fail to develop digital capabilities that makes it possible to work differently and here leadership capabilities are also required to set a vision that has to be executed. Firms that can handle to have both digital and leadership capabilities are called digital masters. Digital capabilities are built by rethinking, improving existing business processes, customer engagements, and their business models. Leadership capabilities are built to envision and drive the transformation (Westerman, Bonnet, & McAfee, 2014).

Westerman et al. (2014) conclude by their research that "*our overarching conclusion from this work is simple: we ain't seen nothin' yet. Within the next ten years, industries, economies, and probably entire societies will be transformed by a barrage of technologies that until recently have existed only in science fiction, but are now entering and reshaping the business world" (p. 7).*

Companies can create a new business model at almost any time. There is no need to wait until the current business model is threatened by the environment e.g. competitors. The transformation of the business model before it is threatened is important because this will help the company to reinforce the presence in the current market. Another reason for rethinking and adjusting the business model is that it will not continue to be successful and create value for both the customer and company. Business opportunities or threats from competitors are often the trigger for companies to change and transform their business model. The choice to design, experiment, and implementing a new business model is often a strategic activity and decision (ibid.).

This confirms that the business model is an important part of the theory of dynamic capabilities. Therefore, the different components in business models which consist of *customer segments, value proposition, distribution channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure* will now be explained shortly (Dijkman, Janssen, Peeters, & Sprenkels, 2015). These components will be analyzed in regards to Google's and Volvo's self-driving car project.

The *customer segment* is defined by the different group of customers that the business model is defined for. The *value proposition* tell what value the company actually delivers to the customer. The *distribution channel* is how and through which channels the company reaches customers and respectively customers segments. *Customer relationships* explain if the relationship is loose or engaged. The *revenue structure* defines the revenue generation, different revenue streams can be used. *Key resources* are assets that are required to make the business model work, and these resources can be either physical, intellectual, human or financial. The *key activities* in a business model are the important actions that have to be performed by the company to create the value proposition. *Key partners* are defined by the network of suppliers and partners the business model depend on. The last component of the business model is the *cost structure* that is described with the most important costs that can be variable and fixed and that inherent to the business model (Bucherer & Uckelmann, 2011).

3.6 Delimitations

The above literature review is a general investigation of the resource-based view and dynamic capability theory, but the focus is on the research area of information technology. Therefore, it is limited by the scope of the dissertation.

The intention of the literature review is to provide theoretical insights on the resource-based view and dynamic capability theory in relation to information technology and strategic management, therefore, I will not discuss whether it can be related to other fields of studies.

The purpose of the literature review in this dissertation is to understand the theories of resource-based view and dynamic capabilities, and how they can be used in this dissertation, which is about information technology. Therefore, I will not provide a historical examination of these theories where I could have provided the evolvement of the theories. This is not within the scope of this dissertation. Thus, I have only reviewed articles with the intention to establish what resource-based view and dynamic capabilities constitutes of and thereby identified concepts that can be used in the case study analysis.

4 METHODOLOGY

The following section provides an overview of the chosen research philosophy, research design, research method, data collection and lastly data analysis.

The ‘research onion’ in Figure 3 indicates how the research can be conducted and which methods belongs to which philosophy. The different parts of the onion will be explained and the choices within this research will be evaluated if necessary. The choices in this research are marked with a red circle.

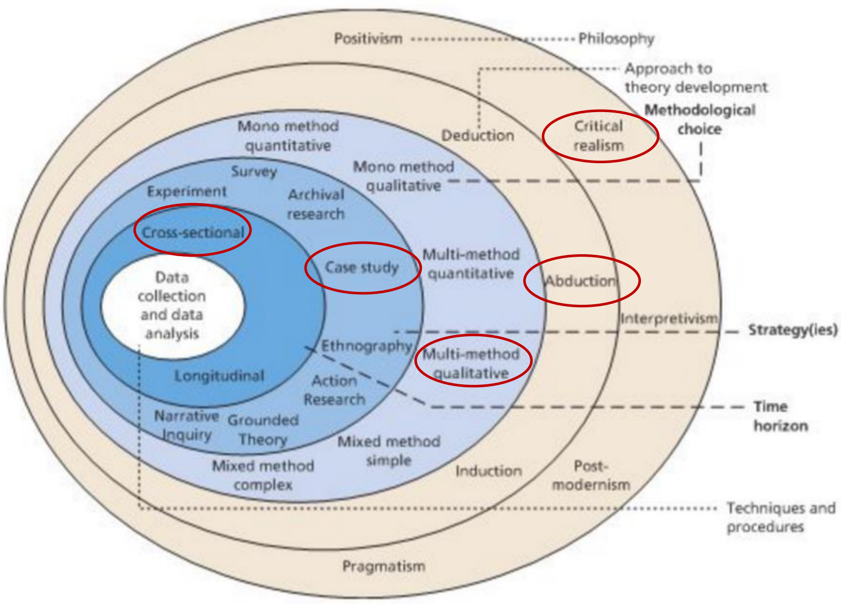

Figure 3: The research onion - Source: Saunders et al. (2016), p. 124

Approach to Theory Development

There are three ways the approach of theory development in a research paper can appear. It can be *inductive, abductive* or *deductive.* In the inductive approach, the goal is to infer theoretical concepts and also patterns from observed data, this is also called *theory-building.* The second one is the deductive approach where the research’ goal is to test concepts and patterns that are known from theory by using new empirical data, this research approach is called *theory-testing.* The purpose for theory-testing is not only to test a given theory but sometimes also to refine, improve or extend. The third research approach is abduction which is a combination of deduction and induction (Bhattacherjee, 2012), it can also be an observation of a surprising fact (Saunders, Lewis, & Thornhill, 2016). Saunders et al. (2012) explain the inductive approach as starting with collecting data to explore a phenomenon and then build a theory. The deductive approach starts with the theory developed from readings, and then a research strategy is designed to test the theory. The last approach, abduction, starts with collecting data to explore a phenomenon, to identify themes and explain patterns, which will generate a new or modify an existing theory, which eventually again will be tested through additional data collection. Abduction is also used when there is a wealth of information in one context, but less in another context. A risk by using an abductive research approach is that it could emerge with no useful data patterns (Saunders et al., 2016).

In this research, an abductive approach is used, as I started to look for a phenomenon or surprising fact that could be interesting to research. Here, the phenomenon of self-driving cars was identified, which gave me a base of data already in the beginning. During evidence collection I read many articles, journals and online sources about self-driving cars and to estimate the future perspective of self-driving cars within this study. Afterward, the context of this paper was decided by using existing theories. Finally, the collected data was used to analyze the research question in regards to the theoretical concepts.

Unit of Analysis

The unit of analysis is important to identify in the beginning of a research, as it defines the data collection and also makes the scope more clear for the researcher (Bhattacherjee, 2012). In this research, the unit of analysis are the *firms*, which are Google and Volvo with their self-driving car.

Time Horizon

The time horizon is short in this research, and can, therefore, be called cross-sectional (Saunders et al., 2016). This means that it is a snapshot taken at a particular time, which in this case study is from January till May 2016.

4.1 Research Philosophy

The assumptions about human knowledge and the nature of realities made in a research process are related to the philosophy a researcher can relate the research to. This research philosophy has an impact on the understanding of the research phenomenon and of the research question, the methods that are used and how the findings are interpreted. The research question is often aligned with the philosophical understanding (Saunders et al., 2016).

The philosophical assumptions make it possible to conceptualize in terms of ontology and epistemology. Whereas *ontology* is 'the nature of reality' and researchers raises questions about how the world operates, *epistemology* 'concerns what constitutes acceptable knowledge' in a field of study. Researchers often align with a research philosophy like *positivism, realism, interpretivism, post-modernism* or *pragmatism*. These research philosophies distinguish by having different assumptions about the ontology, epistemology, how to collect data, how to develop theory etc. (ibid.).

Critical Realism

This master thesis can be positioned as *realism*. Saunders et al. (2012) argue that realism is "*what we sense is reality: that objects have an existence independent of the human mind. The philosophy of realism is that there is a reality quite independent of the mind" (p. 136).* There are two different types of realism, *direct realism* and *critical realism*. Direct realism is the belief of 'what you see is what you get', which mean that the experience we have through our senses shows the world accurately. The critical realist, which will be focused on here, as that is the research philosophy I follow, argues that the experiences we get are sensations. Being a critical realist claims that two steps are available to experience the world. The first one says that 'there is the thing itself and the sensations it conveys'. The second step argues that 'there is the mental processing that goes on sometime after that sensation meets our senses' (Saunders et al., 2016, p. 139). Another thing that is important to mention about the critical realist is the fact that they think that the world is changeable. Also, the critical realist would look at a multilevel study, which means on the level of the individual, the group, the organization. Each of these levels would have the capacity to change the researchers understanding of the phenomenon that is studied. It will also provide an explanation for the observable organizational events, which will be done by looking for underlying causes through which social structures shape the organizational everyday life (ibid.). Easton (2009) argues that the critical realist assumes that there is a real world out there, which tells something about that research is not done only for sake of science, but research is done because there are a real application and use of the research, which in this case can gain insight into the companies of Google and Volvo.

Easton (2009) states that the philosophical approach of the critical realism is relatively new in regards to its ontological, epistemological and axiological issues. Easton (2009) argues that critical realism suits the case research very well, but only if the research process includes in-depth research with the goal to understand why things are as they are. The critical realist's ontology "*assumes that there exists a reality "out there" independent of observers"* (ibid., p. 120). Normally, the aim of a critical realism approach is to answer the question of *"what cause those event to happen?" (Easton, 2010, p. 121).* Using the approach of the critical realist gives a wide range of research methods and strategies that should be chosen and depend on the nature of the object/entity to be studied and what wants to be learned about the entity. Then the data collection can start and the critical realist accepts that there can be differences in the data such as the empirical, the actual and the real data that can both be collected from people, but also material things (ibid.).

Taking the approach of a critical realist in this study is explained by the assumption that the world is changeable. In this case the invention of the autonomous car which makes the world change to a more technological society and makes it the event of research. In this study, I am looking at the entity/object (Easton, 2009) of the organizations Google and Volvo, and how they use their internal resources to compete in the emerging autonomous car market.

4.2 Research Design

The research design is a plan for data collection in a research project. It is a 'blueprint' and aims at describing how these processes should be done; the data collection process, the instrument development process, and the sampling process (Bhattacherjee, 2012).

4.2.1 Research Method

Different research methods can be applied to a research as *quantitative, qualitative or a mixed method* (Saunders et al., 2016). The quantitative method is often used when the data collection technique that is used is e.g. questionnaires, which make the quantitative method use numeric data. The data analysis is often done using statistics or graphs (ibid.). In contrast, the qualitative method is used as a data collection technique with non-numeric data. An example of a qualitative technique is interviews. Here, the data analysis is based on a categorization of data (ibid.). The third method that can be used as a research method is a mixed method, where both numeric and non-numeric data is used (ibid.).

This study has a qualitative approach, as it uses online speeches and interviews as main data collection technique. Furthermore, it is a multi-method qualitative study (Saunders et al., 2016) because not only interviews/talks are used, but also press releases and other online documents. Different research strategies are most normal for the use of a qualitative study. These are action research, case study, ethnography (ibid.). The research strategy used is a case study, which will be explained in more detail in the next section.

Research Quality

To judge the quality of a research, *reliability* and *validity*, can be measured. Saunders et al. (2016) explain reliability as the *"replication and consistency. If a researcher is able to replicate an earlier research design and achieve the same findings, then that research would be seen as being reliable" (p. 202).* Validity refers to the *"appropriateness of the measures used, accuracy of the analysis of the results and generalizability of the findings"* (ibid.). To get a reliable research, it is important to make the whole research process transparent, which means that someone else can follow each step. To make sure that the research is valid, two different techniques can be used: *triangulation and participant or member validation (Saunders et al., 2016).* The technique of triangulation involves using more than one single source of data and also data collection; this in regards to the confirmation of the validity of the research data, analysis and interpretation (ibid.). As explained above, not only interviews are used as data but also press releases and other online documents.

4.2.2 Research Strategy

As mentioned in the above section there are different forms of research strategies, which are shown in Figure 3. The most popular as described by Bhattacherjee (2012) are: experiment, field survey, case research/study, secondary data analysis, focus group research, action research, and ethnography. Saunders et al. (2016) also add research strategies as archival research, grounded theory and narrative inquiry. The research strategy is a plan of how the research question will be answered in regards to the research philosophy and choice of methods to collect and analyze data (Saunders et al., 2016).

In this research, a case study strategy is used based on the two chosen business cases: Google and Volvo and the phenomenon of their self-driving cars and therefore only this type will be explained.

Easton (2009) explains a case study "*as a research method that involves investigating one or a small number of social entities or situations about which data are collected using multiple sources of data and developing a holistic description through an iterative research process"* (p. 119).

Bhattacherjee (2012) adds to this that a case study tries to study the research phenomenon over time in its natural settings. Different forms of data collection are used within a case study: *interviews, observations, prerecorded documents, and secondary data*. The reason for doing a case study is to get an understanding of the phenomenon that is in depth and also comprehensive (Easton, 2010). The cases in this study are the organizations, Google, and Volvo. It is important to understand the context where the case study takes place (Saunders et al., 2016). In relation to this study, the context is with the context and perspective of how these two companies use their resources to compete in the emerging market of autonomous cars. There are several concerns by the use of a case study e.g. the use of small samples (ibid.).

According to Yin (1994), the form of the research question should apply to the research strategy. The form of research question that suits the case study the most starts with either *how* or *why*. The research question in this research starts with 'why', and therefore it matches the chosen strategy of the case study.

4.2.3 Data Collection

Data collection can be carried out in two ways, by collecting either secondary and/or primary data. *Secondary data* is data that has been collected for some other purpose, but can be used in the current study. It can be either quantitative or qualitative. Otherwise *primary data* can be collected, for specifically new data for the purpose of this study (Saunders et al., 2016).

Secondary Data

Both text and non-text documents can be used as secondary data (ibid.), such as organizations communication, their webpages, newspapers, video recordings and thereby transcripts. The use of secondary data can help to triangulate the findings based on other data, like primary data e.g. interviews (ibid.).

The secondary data I am using was acquired through many different distribution channels. Google, TedTalks, YouTube, Google's and Volvo's websites, and other online sources are the sources where relevant secondary data was found. These channels were used because of previous experience and to ensure validity of the used sources and data.

Different terms and keywords were used for the research e.g. self-driving cars, autonomous cars, technology in autonomous cars, Google Car, Google's self-driving car, Volvo's self-driving car, Autonome Autos, autonomes fahren, selvkørende biler etc. These keywords were used in different combinations and languages e.g. English, German, and Danish. Databases provided by CBS library were also used to find articles about the internet of things, technology in autonomous cars and general information about autonomous cars.

Many videos were found with talks and interviews by e.g. engineers working on the Google Car. The duration of these videos varied, going from around 30 seconds up to around 1.5 hours.

At the beginning, each secondary source was downloaded. To support the writing and reading, all links were copied into the thesis as they matched.

An overview of the amount of identified sources that can be used as information and data are given in Table 3.

	Google	**Volvo**	**Autonomous Cars in General**
Number of video-files	3	16	13
Sources of video-files	YouTube, TedTalk	YouTube	YouTube, TedTalk
Number of online sources	10	17	

Table 3: Overview of sources

Not all identified sources were used for the writing process. Sources with poor fit to the study were excluded as useless. Under writing the analysis, it showed that some particular supporting statements were missing. Therefore, I restarted the search on sources e.g. Volvo's website, Google search. It took only short time to find additional, useful sources. All used sources are in the transcription document.

A limitation to this search was that Google only uses three official channels for the distribution of information about the Google Car project, such as Google+[1], YouTube channel[2], and Google Car Project website[3]. This limited the online sources that could be used to find statements and quotes for

[1] https://plus.google.com/+SelfDrivingCar/posts
[2] https://www.youtube.com/channel/UCCLyNDhxwpqNe3UeEmGHl8g
[3] https://www.google.com/selfdrivingcar/

the analysis. Therefore, also other online sources were used to find information about the Google Car project.

Advantages and Disadvantages of Secondary Data

There are several advantages and disadvantages using secondary data. Main advantages of secondary data is reduced time consumption and it can also be used in comparison with primary to triangulate the findings. Use of secondary data can have disadvantages e.g. collected data does not match the specific needs of a research. Another problem might be difficult or costly access to the full data set. Because the researcher did not collect the data himself, there is no control over the quality of data (Saunders et al., 2016). It is important to find secondary data that is suitable for the needs you have, therefore, measurement validity and coverage are important to use as suitable criteria. Measurement of validity is important for secondary data to be used for measurements of the research. Coverage measures if the secondary data covers the population, needed to answer the research question (ibid.). Creswell (2009) also argues that it gives the opportunity for participants in the videos to share their knowledge and thoughts directly.

Primary Data

Second method of data collection is primary data. Primary data is directly collected by the researcher through observation, interviews and questionnaires (Saunders et al., 2016).

In this case study, no traditional way has been used to collect primary data. The way primary data was collected was through a presentation and Q&A/feedback session at Vejdirektoratet (Danish Road Directorate). The presentation started with a 30-minute introduction to my master thesis, followed by 30 minutes of Q&A. I also got the opportunity to gather information about the work of the Danish Road Directorate. Danish Road Directorate is responsible for planning and operating the Danish road infrastructure (Vejdirektoratet, 2012). The reason for my presentation was a project by Danish Road Directorate on self-driving car's (Egense, 2016; Würtz, 2015). This primary data was collected on the 25th of April and was recorded, which enable transcription for easier use in my analysis. If it can be used for further analysis cannot be estimated. No matter what, it gave me an overview and general knowledge of some of the things that will be discussed in Chapter 7. Evaluating the transcription which was done partly indicated that Vejdirektoratet is aware of most open questions regarding self-driving cars, e.g. IT-security issues, infrastructure such a self-driving car would need, reducing number of traffic accidents. Some questions became part of the discussion in Chapter 7. Therefore, this presentation gave me more background knowledge about self-driving cars and is unfortunately not useful as primary data for my case study analysis.

4.2.4 Data Analysis

The data analysis in this case study is based on a qualitative approach. That means that it is derived from words e.g. reports, studies, white papers, essays and web sites. As it comes from text sources, it is important to explore and clarify these words with care. Qualitative data collection is non-standardized data that require classification into categories (Saunders et al., 2016). Creswell (2009) agrees and argues that the data analysis involves making sense out of the text. It also involves to prepare this text and data for analysis, and thereafter moving deeper into the understanding that can be used to interpret the data to conclude on the research question and objective. The data analysis in a qualitative research is an ongoing process starting with raw data like transcripts and documents, continuing to the organization and preparation of data, coding the data to find themes and lastly interpret the meaning of the themes to make a conclusion (ibid.).

The thematic analysis (Braun & Clarke, 2006) is used for the analysis of data. The thematic approach helps with identifying, analyzing and reporting themes within data. A thematic analysis is split up into six different steps; (1) Familiarizing yourself with your data, (2) Generating initial codes, (3) Searching for themes, (4) Reviewing themes, (5) Defining and naming themes, (6) Producing the report (ibid. p. 87). An analysis is a recursive process that requires moving back and forth between the six different stages. The thematic analysis makes it possible to report participants' experiences, meanings and reality (ibid.). Relating this to the research philosophy of the critical realist, it acknowledge the way individuals make meaning of their experience (ibid., p. 81).

Familiarizing with the data in this study happened when I was searching on the internet, I was looking through each video to get to know what it was about to figure out if it was useful to answer the research question. Another thing that was done was to transcribe the videos that seemed useful. Also, press releases and other documents and online sources were inserted into the transcription document and read (USB).

Transcription Process

The transcriptions process began with sorting each talk, interview and online source into the categories of Google, Volvo, autonomous car in general and documents, press releases. The presentation in Vejdirektoratet was inserted first in the document as a primary data source. The transcription was made in Word, as it was easiest to structure and to write in. I decided to make partly-transcriptions as the data I found was not collected by myself, but through online sources that were already available on the internet and thereby secondary. Therefore, I had no influence of the themes that were touched and possibly there were many things that are useless for this research, therefore, the decision about the partly-transcription. Transcribing gives the opportunity to look for relevant quotes that can be used for the analysis. The transcription document was given the layout of tables that consists of the columns: time, answer, coding. Each transcription was given an ID, which will make it easier to use the transcription in the analysis as a reference. An example of such an ID is given in Figure 4, where it is given the ID 'G1' which means Google, transcription no. 1. Other ID's in the transcription document are given as V (Volvo), ACG (Autonomous cars - general), ADP (articles, documents, press release), and Vej (Vejdirektoratet). Each ID was followed by the title of the video or online source. Each transcription also include information about who is talking in the video, or is it about Google or Volvo ('By'), where it was found, when it was published and the length of the video. Text-documents are provided with information about the source, about which business case and when it was published.

G1 - Title: Google Self-Driving Car Project

By: Chris Urmson

YouTube video: https://www.youtube.com/watch?v=Uj-rK8V-rik

From: 12th March 2016

Length: 52:21

Time	Answer	Coding
00:38	…incredibly dedicated team we have at Google whose mission is to improve people's life by transforming mobility.	DC-Sei
00:43	And they come to work every day to push forward trying to make the world better	DC-Sei
04:27	These robot cars are going to do something good for the world, we did not yet actually know how it could work.	
05:28	In 2007 we were really excited about the progress and the defense department said "this is fantastic, you did such progress, the problem is solved". Someone now had to figure out to turn that into a product.	
05:55	In 2009, Google said "let's actually do something about this", let's see if this technology really is ready to go out in the field	DC-Sen

Figure 4: Example of transcription and coding of video

Coding

The next step was to generate codes, this was done in relation to the identified concepts from the theories and is thereby theory-driven. The coding process started with the definition of the codes I wanted to use for the transcriptions. Miles & Huberman (1994) explain a code as *"tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study"* (p. 56). I decided to use codes that match with the chosen concepts within the theories of resource-based view and dynamic capability. An overview of the different codes is given in Table 4.

	Codes		Codes
Resource-based view	RBV	**Dynamic capability**	DC
Valuable	RBV-V	Sensing	DC-Sen
Rare	RBV-R	Seizing	DC-Sei
Imperfectly imitable	RBV-I	Transforming	DC-T
Non-substitutable	RBV-N		

Table 4: Overview of codes

These codes are used for the coding of the transcriptions. All transcriptions were examined and at the same time it was coded. When all transcriptions were coded, they could easily be used in the case study analysis to support Google and Volvo's use of internal resources to compete in the emerging market of autonomous cars.

The above choices indicate that not all steps of the thematic analysis were equally focused on, because searching for themes, reviewing themes and defining and reviewing themes were done at the same time as the analysis was written. This can be a limitation to the thematic analysis.

5 Business Cases

The chosen business cases are Google Car and Volvo 'Concept 26'. Both companies are working on autonomous cars and are therefore relevant to be analyzed and compared.

The choice of these two companies is based on their difference. Google is a high-tech company (KPMG, 2016), very innovative and frequently coming up with new products and services. Volvo is a more traditional Swedish manufacturer in the areas of cars, trucks, buses, heavy construction equipment and marine power. Google is mostly known for Google search engine, with activities in many other B2B and B2C areas, e.g. online sale, advertising, web analytics, social networks, mass data, content and maps. All of this makes it interesting to look at these very different companies.

To give the best insight to the two business cases, I start with a short description of the companies and hereafter go into their autonomous car project they are developing on.

5.1 Google Car

About Google

Google was founded in 1998 by Larry Page and Sergey Brin. Today more than 40,000 employees work at Google. Google themselves calls their employees for 'Googlers' (Google, d). The Google culture allows a great variety of different kind of people and cultures, who share common goals and visions for the company (Google, b). Google is located in more than 40 countries with more than 70 offices around the world. Google headquarter is located in California, USA. Google's goal for all their different products and technologies is "*to make it as easy as possible for you to find the information you need and get the things you need to do done"(Google, c).*

In 2015, Google changed the company structure to a multinational conglomerate with Alphabet Inc. (Alphabet,) on top. Alphabet Inc. owns several other companies which previously were owned by or tied to Google (Wikipedia, 2016). As Alphabet Inc. is the parent company, there exist many subsidiaries e.g. X (previously called Google X). This subsidiary is a semi-secret R&D department. This department is placed in the same town as Googles' headquarter and is responsible for several major projects like Wing, Glass, Look and Self-Driving Car. The mission that the X department is working for is explained by "*We start with a large problem in the world that if solved could improve the lives of millions or even billions of people*" (Solveforx,).

'Google Car' Project

Google's Department X is responsible for the development of the self-driving car. The project is explained as it *"aims to make it easier and safer for everyone to get around"* (Solveforx,).

Google's motivation to launch the self-driving car project is caused by the earlier mentioned facts and statistics of what autonomous cars could do for the society. The self-driven car has driven over 1 million miles and is out on the streets of Mountain View, Austin, and TX and Kirkland, WA. Car models like Lexus SUVs and new prototype vehicles are part of this project. At the moment, all cars have safety drivers onboard (Google, a). The new prototype vehicles are not built only by Google, they have partnered with these companies: Roush, Bosch, Continental, FRIMO, LG Electronics, Prefix, RCO, ZF Lenksysteme and others (ibid.). In 2014, the self-produced prototype was released. This car is an electric vehicle, but for a future release of the Google car, a hybrid car may also be available (Shelton, 2015).

Google started the self-driving car project in 2009. Many years earlier the idea of a self-driving car already existed and working on such technology started. In 2009, the technology was tested on a Toyota Prius on freeways in California (Google, a).

Google is working on a self-driving car that is categorized within level 4-5 (Appendix C) which is full self-driving automation and the "driver" is not expected to take any control (Google, a).

Google's plan of bringing the Google Car to the market is a couple of years from now. They first want to do a lot more testing and also learn what customers might like to use this car for in their daily lives (Google, a).

Each month since May 2015, Google has published monthly reports with the progress of the self-driving car project. In the latest report of March 2016, Google had 21 Lexus autonomous cars, and 33 prototype cars on the streets of their test areas. These cars have in total driven about 2.400.000 kilometer since the start of the project in 2009 (Google, 2016).

Google Car Technology

The technology used in Google's Cars are e.g. sensors that can detect objects in all directions. These objects could be pedestrians, cyclists, and other vehicles, but also plastic bags and birds. The information of the sensors is processed by real-time computers helping the car to navigate safely on the road without getting distracted or tired as humans (Google, a).

To navigate safely the car needs to know: Where am I? What's around (close by, nearby or surrounding) me and does it move? What will likely happen next? What should I do? (Google, a). Google uses its own data centers to process this huge amount of information and data that is gathered by their test cars (Thrun, 2010).

Sensors are used to determine the car's position in 3D. The car combines both map and sensor information to identify street lane and moving direction. The car's real-time computer can predict what all observed surrounding objects might do next, where the pedestrian will move or the cyclist ride. The computer calculates and adjust safe speed and trajectory for the car. The prototype which is developed from scratch is a fully self-driving vehicle, without steering wheel and pedals. To start, the passenger just pushes a button to enter the destination and after a short moment the car starts driving. The first prototype were on the street in December 2014 (Google, a). The cars have worked very satisfactory. The position of the car is within 10 cm of accuracy. This accuracy and knowledge of the cars position can help to minimize the accidents, too. Google Car has only been involved in a few accidents since start of this project and no passengers have been injured. The latest crash was in beginning of March 2016 where a Google car collided with a bus, reasoned by a software issue (Autonomes Fahren & Co, 2016; Google, 2016).

The different components of this prototype car can be seen in Figure 5.

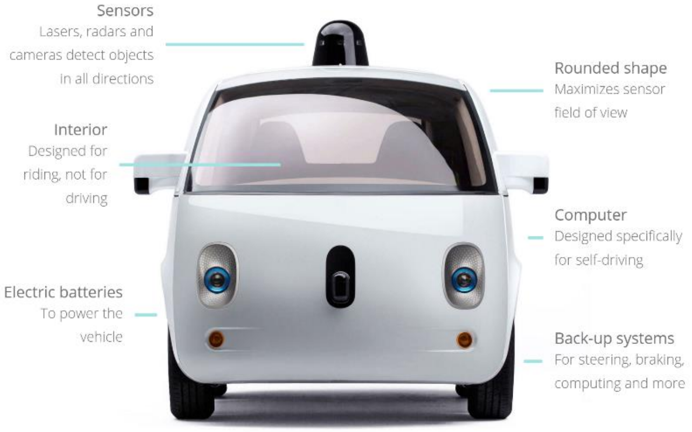

Figure 5 – Google Car Prototype - Source: (Google, a)

5.2 "Concept 26" – The self-driving car of Volvo

About Volvo

Volvo Cars is a car manufacturer that had its first car on streets in 1927 in Gothenburg, Sweden. Volvo Cars have production facilities in Sweden, Belgium, and China and produce many different types of cars. They are represented and have offices around the world, in Denmark they have R&D center and in the US a design center. The biggest sales markets are China, Sweden, and the US. Volvo Cars vision and mission is: *"Our vision is to be the world's most progressive and desired premium car brand. And we believe our global success will be driven by making life less complicated for people, while strengthening our commitment to safety, quality and the environment" (Volvo, 2015a).*

'Drive Me' Project

The self-driving car project in Volvo is called 'Drive Me' and started in December 2013. The vision for this project, which is called Vision 2020 says that *"design cars that should not crash. In the shorter perspective the aim is that by 2020 no-one should be killed or seriously injured in a new Volvo car".* To execute this vision, the plan is to have a test fleet of 100 self-driving cars on roads in 2017 (Mertens, 2015). For the testing of the Concept 26 car, Volvo have chosen to use the streets of Gothenburg in Sweden. The car will have the opportunity to drive up to 70 km/h, and the choice of using a suburban environment exclude pedestrians and plenty of separation between the lanes. To succeed with this project Volvo has chosen to have partners that can help with the support of the cars and the infrastructure these cars will operate in. The cars that are used are of the model XC90s, which is equipped with Volvo's latest self-driving technology (Volvo, 2015d). The partners Volvo are working with are Swedish Transport Agency, Swedish Transport Administration, The City of Gothenburg, Lindholmen Science Park, Chalmers University of Technology and Autoliv (Volvo, 2015b).

Different to many other autonomous car manufacturers, Volvo had made a clear statement about liability when an accident happens. Volvo says *"when the car is being manually driven, the driver is at fault in an accident. But, if the car is in autonomous mode and causes a crash, Eugensson*[4] *said Volvo will take responsibility" (Harris, 2015a; Stevens, 2014).*

'Concept 26' car Technology

The Concept 26 car will have technology included such as cameras, radars, lasers, map data, cloud connection and traffic control centers (Mertens, 2015).

Cameras	4 surround cameras (View: 360°C) Trifolic camera (View: 140°C, Range >150m)
Radars	4 surround radars (View: 360°C, Range >60m) 3 long range radars (View: 20°C, Range >150m)
Laser scanner	View: 130°C, Range >150m
Ultrasonic sensors	4 sensors looking backward 4 sensors looking forward 4 sensors looking to the side

Table 5: Technology in a Concept 26 - Source: (Volvo, 2015d)

A network of computers will process the information gathered from the above-mentioned cameras, radars, scanners and sensors. A high-performance GPS and a cloud-based 3D digital map which will be updated with real-time changes and also the traffic environment is included in Concept 26. To ensure safety, a backup system is available if computers, sensors or anything else should fail. Another situation where e.g. weather conditions make autonomous driving difficult, the driver will

[4] Anders Eugensson – Volvo Cars' director of government affairs

be informed to take over the system, which makes the pedals and steering wheel a must-have in the Concept 26 car (Volvo, 2015d).

Volvos' cars are semi-autonomous cars (Volvo, 2015c; Volvo, 2015e) at the moment they could be characterized as level 3 as shown in Appendix C. With the release of Concept 26, they would go onto level 4, but this will take some years from now. They will not be in level 5, as they have decided to keep the steering wheel, at least in the beginning, and this makes it only to a level 4 autonomous car (Stevens, 2014; Thompson, 2016).

6 Case Study Analysis

The purpose of the case study is to comprise a business case analysis highlighting how the internal resources that Google and Volvo uses are helping them to compete in the emerging autonomous car market.

The analysis will first focus on how Google and Volvo want to achieve their vision, by identifying strategical elements for their self-driving car. Afterwards, tangible and intangible resources that are relevant for comparing the two business cases are identified and analyzed. This is done to look at how they use these resources to achieve competitive advantage. The selected resources will be analyzed in relation to the VRIN framework (valuable, rare, imperfectly imitable, and non-substitutable) identified in Chapter 3. Afterwards, the internal resources will be analyzed regarding Table 2 and the micro foundations (Teece, 2007) within the dynamic capability theory; sensing, seizing, transforming.

Statements and quotes that are used for the analysis, is coming from the secondary data that was selected (USB). Also, the descriptions of the two business cases in Chapter 5 are used as a source for the analysis.

Strategy Identification

To identify the strategies that Google and Volvo are using for their self-driving car projects, it is important to look at their visions. Their visions indicate what Google and Volvo want to be and do in the future. When the visions are clear, the strategy will help Google and Volvo to realize their dreams and achieve them.

Vision

It is important for a company to have a vision, because it makes it possible for the company to have long-term goals and objectives.

Google

Google's overall vision for their different products and technologies is "*to make it as easy as possible for you to find the information you need and get the things you need to do done" (Google, c).*

Looking at the business unit, Department X, they had from the beginning a vision for all the projects they are working on.

"To make it easier and safer for everyone to get around"

Volvo

Volvo identifies a vision for the whole business, which will make the direction for all business units within the concern clear and the business units will know what the goal is.

"*The Volvo Group's vision is to be the most desired and successful transportation solution provider in the world"*

(ADP19)

"Our shared vision strengthen the Volvo Group and improves our potential to seize new business opportunities, drive development, advance our position, capture market share, and help our customers create value"

(ADP27)

For their self-driving car project, Drive Me, Volvo has formulated a vision statement, which is called Vision 2020.

"*Design cars that should not crash. In the shorter perspective the aim is that by 2020 no-one should be killed or seriously injured in a new Volvo car"*

Strategy

The strategies explain what Google and Volvo are going to do to achieve their formulated visions. The strategy is also an overall plan for the deployment of resources for the establishment of a favorable position in the dynamic environments.

Google

The first strategic element that can be identified to realize their overall business vision, is the establishment of their Department X, which is a semi-secret research and development department, working on projects that could be a success in the future.

"We look for the intersection of a big problem, a radical solution, and breakthrough technology. We start with a large problem in the world that if solves could improve the lives of millions or even billions people. Then we propose a radical solution that sounds impossible today, almost like science fiction. Lastly, we look for a technology breakthrough that exists today; this gives us the necessary hope that the solution we're looking for is possible, even if its final form is five to ten years away and obscured over the horizon"

(ADP23)

Department X's vision to get people move easier and safer is included in the above statements, as they search for new opportunities by looking at specific problems and how they can be solved using breakthrough technology. Relating this to the Google Car project, it will help people get around, also those that could not drive before because of age, healthiness etc. and it will make it safer by the use of advanced technology.

There are many different elements in the realization of the Google Car project, and it is therefore a part of their strategy and actions that are taken, to obtain their long-term vision sometime in the future.

Department X started the Google Car project in 2009, and has since been working on the development of a prototype car that can help with the realization of their vision.

"For the past six years, Google has been testing autonomous vehicle technology. Then, in 2014, the company released its own vehicle: a compact self-driving car with no steering wheel or pedals, built from the ground up"

(ADP7)

To make this development happen, it is important to have employees with knowledge about the technology and other important aspects. Department X have many employees and their backgrounds are varied.

"X is a team of inventors and entrepreneurs from a wide variety of backgrounds. We're makers, engineers, and scientists with deep technical expertise who've come to X to bring our creations out of the lab and into the real world"

(ADP24)

This gives the Department X a lot of knowledge, which they can use for the development of the Google Car. Because Google, and thereby the Department X, is not a traditional car manufacturer, but known as an advertisement company, they have decided to have partnerships to help them develop the Google Car.

"It takes a lot of parts to build a car – especially a fully self-driving one. To build out prototype, we worked with established automotive partners from around the world"

(ADP11)

The strategic elements to realize their vision has been identified, with examples such as a department that actually work for the realization and resources that are allocated to this department. Also, the building and development of a self-driving car and its testing is part of their strategy. To build and develop the Google Car, the resource of humans and their knowledge is allocated to Department X, which is a decision that is made in the management of Google, because they probably believe in the success of the project. To get enough knowledge, Department X is working together with partners to have full knowledge about how to build a self-driving car.

Volvo

Volvo has a vision for their self-driving car project, Drive Me. Volvo is more specific than Google and plan on an actual year where their vision should be realized. Volvo's management also define what position they want to be in in 2020.

"We are among the most profitable in our industry: We are our customers' closest business partners, we have captured profitable growth opportunities, we are proven innovators of energy-efficient transport and infrastructure solutions, we are a global team of high performing people"

(ADP20)

Relating the above position to their Drive Me project, they will definitely obtain the position of; *capturing profitable growth opportunities* and to be a *global team of high performing people*.

Peter Mertens, the research lead at Volvo, argued in the beginning of the Drive Me project that Volvo had identified the challenges and opportunities in self-driving cars.

"We have gone to great lengths to understand the challenges and opportunities that autonomous cars will bring to people in coming years,"

(ADP4)

Volvo started their Drive Me project in 2013 and their goal is to have real-world customers test and use one of the 100 self-driving cars that will drive around in Gothenburg by 2017.

"Self-driving Volvos are already on Swedish roads, and by 2017, real-world customers will be using 100 self-driving Volvos on public roads—the world's first large-scale autonomous drive project"

(ADP1)

Erik Coelingh, the safety expert at Volvo also argues that the self-driving car is a step toward the achievement of their vision, and by testing the car the created value will be valuable and ensure a successful implementation.

"Developing a complete technological solution for self-driving cars is a major step. Once the public pilot is up and running, it will provide us with valuable knowledge about implementing self-driving cars in the traffic environment, and help us explore how they can contribute to sustainable mobility. Our smart vehicle are a key part of the solution, but a broad societal approach is vital to offer sustainable personal mobility in the future. This unique cross-functional co-operation is the key to successful implementation of the self-driving vehicle"

(ADP14)

This shows that they have a clear strategy of how they want to achieve their Vision 2020. For this, they also need a huge knowledge base for the development of the Concept 26. Here, Volvo has the knowledge about how to build a car because it is a traditional car manufacturer. But, Volvo has also decided to have partners for their Drive Me project. The CEO of Volvo, Håkon Samuelsson, says that they need partners, to bring this technology on to market faster and to realize their vision.

"We needed to bring partners on board. Our motivation for doing so is simple. This is a technology that can save lives, clean the air, make cities less congested and free up time for people. Who would not want that in place as soon as possible?"

(ADP17)

Looking at the strategic elements for Volvo, and how they want to realize their Vision 2020 it also consists of elements such as building a prototype and start testing it. To understand what the challenges and opportunities of a self-driving car project are, and to translate this to their Concept 26 car is also a way to execute their vision. The testing in Gothenburg in 2017 is a concreate plan for achieving their Vision 2020 and in-house knowledge about building cars and partnerships with knowledge about things will help to realize their vision on time.

With the right strategy where resource allocation is an important part, Volvo and Google can obtain competitive advantage. Therefore, I will now go on to an internal analysis of the tangible and intangible resources of Google and Volvo and analyze them in relation to the VRIN framework identified in Chapter 3.

6.1 Internal Analysis

The internal analysis of resources is divided into tangible and intangible resources where resources such as data centers, technology, patens, brand recognition, and knowledge/know-how will be part.

Tangible resources

Even if these tangible resources are not the core competences of Google and Volvo, they are still important to briefly look at, as they are an important part of their self-driving car projects.

<u>Data centers</u>

In regards to the selected sources for the analysis, it could only be identified that Google own a data center. In the data center, Google is analyzing the produced data that a Google Car is conducting when driving around on streets.

"*Our data centers use 50% less energy than the typical data center. [...] We've learned a lot in over ten years of designing and running our data centers. We've outlined our best practices to help other data centers run more efficiently"*

(ADP26)

Valuable, the data center will help the Department X to be more effective in regards to producing the result of a fully autonomous car and thereby make their strategy be implemented. It will also serve as a key factor to keeping the autonomous cars updated. This makes the data center a valuable resource for Google.

Rare, it seems that Google is the only one owning a data center to analyze the conducted data, which makes it not possessed by competitors. Therefore, the data center is a rare resource.

Imperfectly imitable, Google have probably invested a lot of money in their data centers, but other could imitate and also build up a data center, if necessary.

Non-substitutable, the data center that Google has could not be substituted by anything. There is currently no other technology that can substitute the technology used in the data centers, nor is there any other way to safely store large amounts of data.

The short analysis of the data center resource owned by Google shows that it is a valuable, rare and non-substitutable resource, but could be imitated by others, even if it would be costly.

Technology

The technology that is used in the Google Car and Concept 26 has already been described in Chapter 5.

One of the technologies that Google is using for their cars is the LIDAR radar on top of the car. This LIDAR radar is only used by Google, probably because it is really expensive.

"*So does a Velodyne-64-fold laser, such as Google have it on the roofs of their research cars cost about 60.000 Euros"*

(ADP10)

As this is too costly for others to imitate, many other car manufacturers choose to substitute such a radar with cheaper ones. To this, Volvo's safety expert Erik Coelingh argues that Volvo is unique because their development and research of technologies is different than others.

"One powerful thing that we have that other brands don't is that we are a comparatively small company – we don't have a separate research organization. We have research and product development in one organization so we have the capability to develop an idea into a product very

quickly. We've shown that with our active safety technologies. We are the ones that put innovative technology into production first"

(ADP25)

Valuable, The LIDAR radar technology makes it possible for Google to implement the strategy to realize their vision of making it easier and safer for people to drive around. Additionally, it can also be a disadvantage, because customers might not afford the car because of its price, which will be based on the technology that is used in it, and when one of the radars are that expensive, it could make the implementation of the strategy impossible. But of course, the LIDAR radar is one of the best radars and makes the 'more safe' element of the vision possible. On the other hand, Volvo's combined development and research organization makes them capable of taking the lead with new technologies. Therefore, this organizational is valuable to Volvo.

Rare, Only Google is using this kind of technology because of the price, therefore, it is not possessed by others. Volvo argues that their organizational structure is unique, because they are a smaller company and larger companies does not currently possess the same structure that makes the development of new technology possible.

Imperfectly imitable, the LIDAR radar is imitable. This is already seen by many other car manufacturers that use cheaper radars, but have the same specifications, possibly the quality and accuracy is worse. If other companies would imitate the LIDAR radar, it would be costly. The safety expert of Volvo, Erik Coelingh says that similar components are used, but the integration is different.

"*The components and sub-systems are similar. The key is the integration, the writing of the software"*

(ADP25)

Non-substitutable, the LIDAR radar is easily substitutable. Other car manufacturers than Google, use other kinds of radars, this includes Volvo. They want to use qualitative technology for their car, but also argue that it has to be affordable by customers. Erik Coelingh, Volvo's safety expert says that the car should be affordable.

"Well, our ambition is unique. […], we have to have a technological solution that is feasible, affordable and producible within a relatively short time frame we have. And I think that's really

unique within the industry"

(ADP14-09:17)

The analysis of the technology as a tangible resource shows that Google's LIDAR radar can be categorized as valuable and rare, but it is not imperfectly imitable and also it is not non-substitutable. The technology organization of Volvo is also valuable and rare, because it creates value for Volvo and no other company currently possesses it. However, it is easily imitated or substitutable, even at a low cost.

Intangible resources

<u>Patents</u>

Patents are important for companies to have, because they can in that way protect their products and services. Google and Volvo are having patents for their Google Car project and Drive Me project.

The Google Car project have since it started patented many of their technologies in the car.

"[…] the tech company continues to expand its autonomous patents – last month it added a pothole detection system to the list"

(ADP7)

Volvo have also patented parts of their Concept 26, but it does not seem that they have as many as Google has.

"*Concept 26 is based around an all-new patented seat design that actively cradles the driver during the transformation phase into one of the three modes: Drive, Create or Relax. With these three modes the concepts creates a new autonomous drive innovation platform that can adapt to new needs and technologies over time"*

(ADP21)

Valuable, patents are a strong way to keep ahead of competitors, while also protecting your own technologies and assets. In today's world, patents are upheld and checked by companies much more than we have seen before. Therefore, the patents are valuable for both Google and Volvo. They simply help them protect their prototypes and the technology used in them.

Rare, while patents are quite valuable to both Google and Volvo, they are not rare. This is because any other company, or even person, can create a patent on something. Currently, other car manufacturers possesses patents on prototypes and technologies.

Imperfectly imitable, due to the way the patent system works, only one company or person can hold a given patent. Therefore, it is not possible to imitate patents. However, patents have a due date and will expire, but even this will not make it possible to imitate an expired patent. This makes it a non-imitable resource for both Google and Volvo.

Non-substitutable, since patents are exclusive to the owners and there exist no other system than the patent system, patents are non-substitutable. This is an advantage for both Google and Volvo now and in the future.

The analysis of the patent as a resource, shows that it is valuable, non-imitable and non-substitutable. However, it is easy for companies to create new patents and competitors of both Volvo and Google already possesses many patents. It is possible for competitors to imitate and substitute the technologies that the patents are protecting e.g. if the LIDAR radar is protected by a patent, others could imitate it or substitute it with a cheaper one that have some of the same specifications, but is not the same. It is not favorable for competitors to imitate exactly the same as the technology that is patented, since this can be seen as breaking a copyright and become very costly.

Brand recognition

Brand recognition is an important intangible resource for companies, because potential customers will often chose brands they recognize and leave out brands they do not.

Volvo has since the company's start in 1927 build up a strong brand, where it now enjoys a solid market position.

"*The Volvo brand, which has been built up over decades, enjoys a solid position worldwide. The Volvo brand is one of the world's best known and respected brands within the commercial vehicle industry. It is associated with the core values quality, safety and environmental care*" (ADP22)

Volvo is a traditional car manufacturer that can brand itself with the mentioned qualities. In regards to Google, it is known for something totally different than building and developing cars. Its most known product and service is its search engine. In recent years, Google have also been building a brand as a technology company, which will help them when publishing their autonomous car.

Valuable, both Google and Volvo are well known and strong brands. Customers knows what they can expect from both companies. Volvo’s brand is valuable, because they are known as a car manufacturer that makes reliable cars. Google on the other hand is mostly known as a tech company. This is also valuable, however, not as valuable as Volvo’s brand when looking at the autonomous car market.

Rare, any company can have a brand and be recognized by it. When looking at competitors to Google and Volvo they also have their own brand, which makes the resource common. It is important to note that customers might recognize a brand either positively or negatively, and that this is dynamic and can change over time.

Imperfectly imitable, the brands of Google and Volvo cannot be imitated and are therefore imperfectly imitable resources. However, the recognition of a brand can be imitated. It does however take quite some time to build the same recognition that both companies have.

Non-substitutable, a company’s brand is often recognized either by their name or their logo. These two are central to any companies and cannot be substituted by anything. Therefore, the brands of Google and Volvo are a non-substitutable resource.

The above analysis of the brand recognition resource, shows that the resource is valuable, imperfectly imitable and non-substitutable for both Google and Volvo. It is however not rare, since other companies, like BMW, Volkswagen and Citroën also possesses a brand. While a brand as a resource could give competitive advantage, it could also lead to disadvantages, since it can be recognized for either something positive or something negative. It might even change over time. A good example of this, is the Volkswagen brand, who until recently was known as a reliable manufacturer. However, a report showed that they had fiddle with the particle emission. This changed their brand negatively.

Knowledge/Know-how

The human resource of knowledge and know-how is the last intangible resource that will be considered in the case of Google and Volvo.

Google's knowledge base is brought together by many different employees. This makes it possible to be an innovative company that is good at exploiting new opportunities. Where other car manufacturers do have a lot of know-how about how to build cars, Google needed to have partners that could help them with this challenge. Therefore, they have partnerships with e.g. Bosch, Continental, LG Electronics. These partnerships contribute with a lot of valuable knowledge which can be used as a resource to build the Google Car.

"*Our engineers build the software that the vehicle use to understand their environment, and we also have a team of safety drivers who test the software in real-world situation"*

(ADP9)

Volvo's knowledge is coming from in-house knowledge about how to build cars, which gives them the advantage of not having to rely on partnerships to develop a self-driving car as they can build the car themselves. Anyhow, Volvo says that they have employed qualified people, but add to this that partnerships are evolving, because they get support from those partners.

"*We have been investing a lot of time and money to improve the Volvo drive experience. We have employed the best engineers and used the latest and greatest technology to ensure that we deliver really something special"*

(V2-00:45)

"The Swedish Transport Administration, the Swedish Transport Agency, Lindholmen Science Park and the City of Gothenburg, and is endorsed by the Swedish Government"

(ADP1)

These partnerships show that Volvo does a lot of their development of self-driving car on their own, but have partners that support the project and support it to get their Vision 2020 realized.

Valuable, both Google and Volvos knowledge and know-how is valuable. Without it, they would not be able to create the autonomous car they are currently working on.

Rare, the knowledge that is present in Department X and the competences that each employee has is rare. This is because only Department X has the particular employees and makes it difficult for others to possess the same. Through the testing of Google Car, each employee learns more every day, and this can result in building capabilities which can give Google advantages. The rarity of this internal resource is coming from that Google is having a project team dedicated to the self-driving car project. Different teams are included in this project and some of the groups are the product team and the system engineers.

"*The product team is taking the technology and all the energy of all that stuff we are working in and putting into a form that can be used by real people […] System engineers: work […] to take what […] and his team envision and write that down and figure out how that can happen"*

(G3-05:48)

Google has their own hiring process where computers are analyzing people in regards to different factors, and thereby only the persons that fit into Google's culture will be employed. This makes it difficult for other firms to have this resource, as many want to work for Google.

The knowledge that Google has is therefore rare. If we look at Volvo the same cannot be said. The knowledge Volvo currently have is about manufacturing cars. This knowledge is also possessed by all their competitors and is therefore very common. They have, however started building a knowledge base for the technologies in the autonomous car, which will be rarer.

Imperfectly imitable, knowledge about how to build a car can easily and with few costs be imitated by other car manufacturers. The same applies to Concept 26, which uses technologies such as sensors, lasers etc. In an online press conference held by Volvo where some of the responsible of the Drive Me project participate, the question 'What is unique about the technology? Volvo is using, almost all car manufacturers present some kind of self-driving car what's so special with your solution?' is answered by Erik Coelingh (safety expert, Volvo).

"Well, our ambition is unique. Our ambition to have a creative and attractive offer to real customers in real cars on the real road. Being so concrete we have to address all aspects of the self-driving car, the legislation aspect, we work with traffic authorities, with city planners and by being so concrete, we have to have a technological solution that is feasible, affordable and producible within a relatively short time frame we have. And I think that's really unique within the industry"

(ADP14-09:17)

This is just an indication, but not a clear answer to the question, and this shows that the Concept 26 car possible is somehow the same just as some of the many other car manufacturers are developing and therefore imitable. The same applies to Google, the car could easily be imitated, but with costs.

Non-substitutable, the knowledge and know-how that employees have in the Google Car project and the Drive Me project can be substituted by other people that have the same knowledge and insights into how to build a self-driving car. The only knowledge that is not substitutable, is the tacit knowledge each employee could have obtained through the process.

Findings

Based on the above analysis of the internal resources in regards to the VRIN framework Table 6 have been created. It shows each internal resource and which of the VRIN attributes they contain for each business case. This figure will be the base for the analysis of how good each company is at obtaining sustained competitive advantage and which stage they are currently placed at.

Starting with Google, we see that both the data centers, the technology and the knowledge resources are missing the imperfectly imitable attribute. These resources will place google at a temporary competitive advantage stage. The resources are currently owned by Google and are rare. However, competitors can imitate them and will do this at some point in the future. It is therefore only a temporary advantage that will fade away. On the other hand, the resources of patents and brand are quite common among Googles competitors. These resources therefore lead to competitive parity, because Google is on the same level as their competitors.

Much of the same can be said about Volvo. They do currently not own any data centers, which lead to a competitive disadvantage compared to Google. Again, the technology and knowledge leads to a temporary competitive advantage and the patents and brand leads to competitive parity.

All in all, Google and Volvo are not able to achieve sustained competitive advantage with the found internal resources. They are currently holding resources, which gives them a temporary competitive advantage at most.

	Data centers	**Technology**	**Patents**	**Brand**	**Knowledge**
Google	Valuable Rare % Imperfectly imitable	Valuable Rare % Imperfectly imitable	Valuable % Rare Imperfectly imitable	Valuable % Rare Imperfectly imitable	Valuable Rare % Imperfectly imitable

	Non-substitutable	% Non-substitutable	Non-substitutable	Non-substitutable	% Non-substitutable
Volvo	Do not own data center	Valuable Rare % Imperfectly imitable % Non-substitutable	Valuable % Rare Imperfectly imitable Non-substitutable	Valuable % Rare Imperfectly imitable Non-substitutable	Valuable % Rare % Imperfectly imitable % Non-substitutable

Table 6: Analysis of VRIN framework - Google and Volvo

6.2 Dynamic Capabilities

It is important for Google and Volvo to build dynamic capabilities by the use of their internal resources, because this will give them the opportunity to resist and address the rapid changing environment in the emerging market of autonomous cars. For that reason the concepts of sensing, seizing, and transforming will be used to look at how good Google and Volvo are at doing that.

Sensing

Google

The sensing of new opportunities is one of the competences and processes that Google has been good at by having their research and development department X. Department X gives them the opportunity for value creation. In relation to Google Car, Google was one of the first companies to start the development of a self-driving car. Department X spotted the opportunity of a new way of transportation in 2009.

> "*Let's actually do something about this, let's see if this technology really is ready to get out in the field and having people use it"*
>
> (G1-05:55)

The development within the emerging market of autonomous cars shows that many car manufacturers have followed the direction that Google started, by introducing their own self-driving car projects. This gives Google several competitors and makes it even more important to build dynamic capabilities. Google's early entry into the self-driving car market gives them benefits in relation to their expertise, knowledge and know-how.

It is difficult to sense customers' changing needs for the self-driving car project. This is because customers first knew that self-driving cars could be a reality when Google introduced it. A general customer need is given in the benefits of self-driving cars, e.g. time for taking a nap while driving, or working. Department X's objective and process is to find a big problem, in this case many people get killed in traffic and a lot of jam's costs money and then look for technologies that could solve the problem.

Another process that has been important and is visible for department X, is the search for potential collaborators, such as suppliers and partnerships. As mentioned earlier, department X work together with many different partners that can be seen in Figure 7.

Volvo

Google was the first actor that introduced a self-driving car project to the car industry. Volvo sensed opportunities in this new technology in 2013.

"The project was initiated in 2013. The first test vehicle have been on the road in Gothenburg since 2014 – and Volvo Cars has recently taken a major leap forward by presenting a complete system solution for self-driving cars. The public pilot is scheduled to start in 2017"

(ADP15)

That means that Volvo started their work four years after Google introduced their Google Car project to the public. Volvo tries to keep up with the rapid development in environment and technology and also their competitors.

"We are in the most intense period of investment and transformation in the company's history. Volvo Cars is a company that has set itself high goals. We will continue our strategy to reach them in the coming years"

(ADP18)

They invest heavily in this project, this shows that they want to be one of the key players within the development of the self-driving car. As mentioned before, Volvo want to have 100 test cars on roads in Gothenburg by 2017. That supports the statement of that Volvo Cars have set itself high goals.

Volvo have decided that their process to sense and select new opportunities and ideas is executed by only one department, which makes the process quicker.

"We have research and product development in one organization so we have the capability to develop an idea into a product very quickly"

(ADP25)

To make sure that Volvo identify the changing customer needs and identify the right segment for their development, they have processes such as research to identify those. Volvo's interior design chief, Robin Page argues that it is important because Volvo's business is about people.

"Or research clearly shows that some people will want to use their commuting time creatively when they have full autonomous drive available, while others will want to just sit back and relax, watch online media or listen to music"

(ADP3)

To create as much value as possible for Volvo's customers that will drive with Concept 26, Volvo decided to use a complementor such as Autoliv. Autoliv is known for being very innovative in safety technologies.

"The two companies will work together to share research and development into the latest safety technologies and engineers and other industry experts from both companies will collaborate to push forward the introduction of active safety systems"

(ADP16)

<u>Seizing</u>

Google

To mobilize the Google Car project resources such as knowledge, know-how, patents, technology and others have been developed and used since the project start in 2009. Chris Urmson, Director at the Google Car project says that their human resources is coming from many different members of the Google Car project team.

"Incredibly dedicated team [...] at Google whose mission is to improve people's life by transforming mobility. And they come to work every day to push forward trying to make the world better"

(G1-00:38)

That shows that human resources is one of Google's core competences, which help them to compete in the dynamic and rapid changing environment. Googlers are very committed to the project and this makes the development of the Google Car are rapid developing project.

Based on the business case description, secondary data and the above analysis, it is possible to compile a business model canvas for the Google Car project. It is important to constantly look at this business model and adjust it, because it is important to have a business model that can make the Google Car project create value for Google, and create value for the customers. It is also important for the dynamic capabilities.

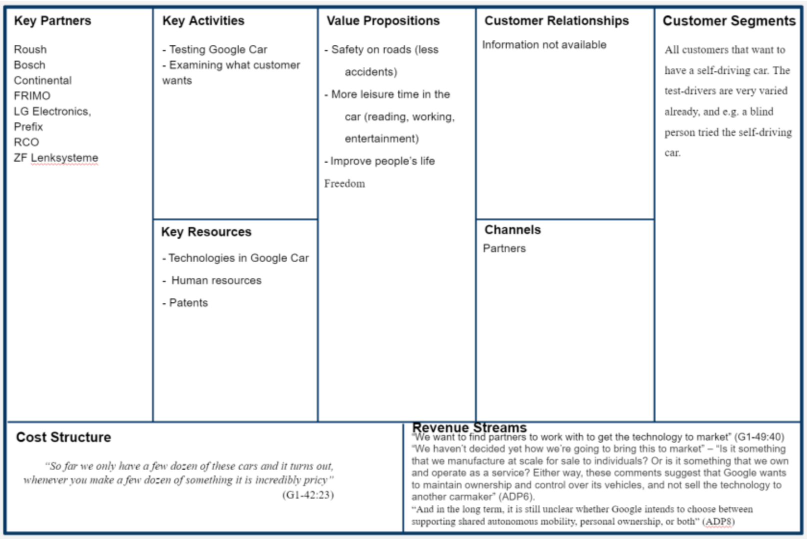

Figure 6: Own depiction of business model canvas for Google Car

Volvo

Volvo has been committed to the research and development of the Drive Me project to achieve their Vision 2020 that states that no one should be killed by 2020 when driving Volvo. To ensure this vision and make it real, Volvo has chosen to work together with some partners, among others Chalmers University and Autoliv. The reason for Volvo to have partners is e.g. having academic partners that can come with a more scientific perspective on the project.

> *"Will strengthen the project's scientific dimension, which will not include independent research and programmes for educating new experts"*
> (ADP15)

It will strengthen the development of new experts who can bring more human resources as knowledge and know-how to the Concept 26 development. Another partner is Autoliv, they are also known for having capabilities and competences within the field of safety.

> *"Will work together to share research and development into the latest safety technologies and engineers and other industry experts from both companies will collaborate to push forward the introduction of active safety systems. […] alliance will generate significant benefits. Autoliv's established R&D and engineering expertise in automotive safety will contribute to the development*

of cutting edge active safety and autonomous driving technologies"

(ADP16)

These partnerships indicates that Volvo do everything they can do get their Vision 2020 a reality. Knowledge sharing with these partners will strengthen their existing internal resource of knowledge and know-how to build their self-driving car, Concept 26.

The investments to self-driving car projects is something none of the companies want to tell the public, because of the huge competition and the question 'Who do first release a self-driving car?'. Volvo do invest a lot of resources, such as money time and earlier mentioned human resources, spending money on patents into the project. In an online press conference Volvo say that they cannot tell the public how much because of competition.

"It's a lot and we spend start spend a lot of money in that because we think it is important. We will fulfill our Vision 2020 where no one is going to be killed or injured in a Volvo. […] bringing in partners, so we share the burden amongst interested partners in the project"

(ADP14-24:47)

Volvo's commitment and investments into their Drive Me project makes them build seizing capabilities and gives them both value creation and value capturing opportunities. To see how Volvo further wants to create value for both themselves, but also the customers, a business model canvas has been compiled.

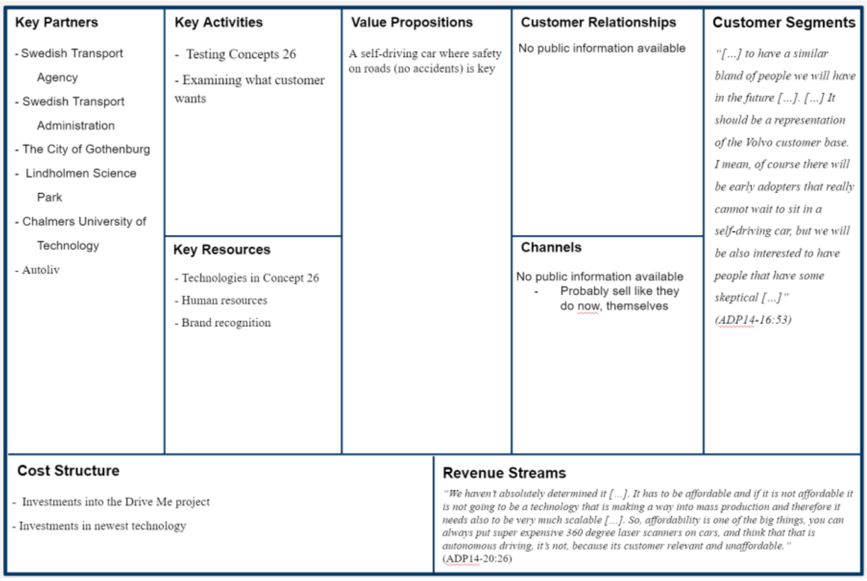

Figure 7: Own depiction of business model canvas for Concept 26

Transforming / Reconfiguring

Google

Google is known as a very innovative company. This view can also be applied to their Google Car project. Google tries to use only the best and newest technology such as sensors, radars etc. and thereby try to renew their resources of technology. Co-specialization can help Google to achieve sustained competitive advantage. Co-specialization in the Google Car project could e.g. be the combination of their unique internal resources of intellectual property (patents) and human resources, the employees and their tacit knowledge. These resources are more valuable in combination than on their own and protects the Google Car project from being threatened by competitors that try to imitate or substitute the whole project. It is important to protect intellectual property rights, such as the patents that Google have invested in. This contributes to the protection of specific knowledge or invented technologies. Knowledge management is important for dynamic capabilities, as learning, knowledge transfer, or know-how integration from partnerships can help to increase business performance. Google do that by having established different partnerships that can be seen in Figure 7. These partnerships can be a source for Google to learn, and that can give Google the opportunity to recognize dysfunctional processes or routines, which can help to avoid strategical blind spots.

Volvo

Volvo's brand, their achieved patents and their human resources have become co-specialized over time. This can give them more sustained competitive advantage. Especially their resources of brand recognition and human resources such as knowledge are more valuable in combination because without their knowledge of e.g. safety, they would not be recognized as a brand that is specialized in safety technology. To expand Volvo's knowledge management, they also use partnerships for knowledge transfer and know-how integration. Here the example of the partnership with the Chalmers University can be used, where Karin Markides, the president at Chalmers University of Technology, argued that they decided to get partners because they can bring knowledge and research capacity into the project

"Drive Me is perfectly in tune with our aim to be an academic powerhouse in the field of automated transport solutions. We will bring knowledge and research capacity to the broad Drive Me approach, which will be crucial in ensuring the efficient integration of technological and

organisational mobility solutions in the future"
(ADP15)

Findings

Based on the analysis above, we can compare Google and Volvo, to see which of the companies have been better at sensing, seizing and transforming. It is clear that Google have been better than Volvo at sensing the new technology. This is also one of the strengths of Department X and one of the things Google have been known for in the last decade. They have then been less good at seizing the technology to gain competitive advantage. Lastly, they have been transforming well, trying to establish competitive advantage by creating their own version of the autonomous car and storing all data it collects.

Volvo was on the other hand, late arrivals to the autonomous car market. They have not been good at sensing the new technology and have been behind Google from the start. They have, however been very aggressive when seizing, which makes them very strong in this phase. In the last phase, they have been trying to establish competitive advantage, just as Google has.

7 Discussion

The purpose of this discussion is to explain, review and interpret the methodology, the analysis and its findings; as well as to stimulate a general discussion about self-driving cars. Firstly, I will discuss the theories and the findings. Secondly, I will discuss the methodology. Lastly, a general discussion about autonomous cars and how these cars affect the whole environment.

7.1 Discussion about Theories and Findings

Theories and Findings

<u>Resource-based view</u>

Throughout the analysis, two main theories have been used. Both theories are broadly accepted in the literature, but they also have some limitations. The resource-based view theory is not always possible to use in a rapidly changing environment because sustained competitive advantage can be hard to obtain, when the internal resources are constantly changing. This is important to remember, when analyzing the car industry, since it is a rapidly changing market. Companies need to be ready to change and renew their internal resources to fit the environment. This is the reason for including the dynamic capabilities theory. This theory is often used when analyzing companies in rapidly changing environment, since it describes how fast a company can react to changes in the environment. The combination of these two theories is often used as they describe a given company's assets and how well they are at utilizing them to capture opportunities.

The analysis of the companies' visions and strategies shows that both companies are well underway to achieve their visions. The vision of the Google Car project was to make transportation easier, faster and with less accidents. While this is currently not achieved, they do have prototypes on the roads and their initial results shows that autonomous cars are good at avoiding accidents and are chosing the faster routes, while the person in the car is able to be productive. This shows that Google is implementing a strategy to achieve its vision. The same can be said about Volvo. Their vision is that no one should be killed by a Volvo car by 2020. Volvo has a clear strategy of working with researchers, while at the same time trying to get their autonomous cars on the road as fast as possible, and in larger numbers than any other project in Europe. Spender (2010) states that a company achieves competitive advantage, when a value creating strategy has been implemented and no other competitors has implemented the same strategy. Currently, neither Volvo nor Google has fully implemented a value creating strategy for the autonomous car, nor has any of their competitors. The first one to actually implement such a strategy will receive competitive advantage.

The internal resources used in the analysis were chosen because they are important to the companies in the car industry and because they could possibly help them to achieve sustained competitive advantage in the future. It is important to note that these are not the only resources the companies might possess. One such resource might be IT, which both companies should possess by now. However, IT was left out, because Bharadwaj (2000) argues that any investments in IT can be imitated by competitors and it is therefore not a firm specific resource.

The pool of resources for the two business cases was chosen to be the same: data centers, technology, patents, brand recognition and knowledge. Parida et al. (2016) state that some companies might be better at managing this pool of resources than others and they will therefore also be better at implementing their strategy because of full resource exploitation. The analysis showed that this is not the case with Google and Volvo. They are currently on an equal state and are not fully exploiting their internal resources. Again, if other internal resources had been analyzed, the outcome might be different. Other resources, which could be interesting to look at are: financial resources, company culture and infrastructure. The financial resource is especially interesting, because it could help to understand what the companies invest their money in and thereby also where they differ. Teece (2010) argues that investments are an important element of a company's strategy and therefore looking at the financial resource could have helped determine their strategy in even greater details. The financial resource was not included in this analysis because both Google and Volvo are keeping the investments in these specific projects as corporate secrets due to fierce competition currently in the market. The culture of the two companies is also fundamentally different and could be interesting to analyze.

Dynamic Capabilities

The autonomous car market is new and is not really a market yet, since customers are not able to buy autonomous cars yet. It is, however an emerging market and this also makes the environment that the companies are in rapidly changing. Katkalo et al. (2010) states that companies possess the opportunity to evolve or co-evolve their capabilities within a rapidly changing environment, by the means of sensing, seizing and transforming. Furthermore Teece (2011) argues that a company requires these activities to actually stay in a market that is changing. He also argues that different companies will be better or worse at performing some or all of the phases. The analysis of the two companies' handling of the new market and the three phases showed that both have been doing the phases. Initially Google was stronger at sensing the opportunities the new market offered, but later Volvo had been stronger at seizing the opportunity by implementing a strategy for getting their cars on the road quickly.

The analysis showed that Google had been good at sensing the opportunity, which gave them a head start and competitive advantage. They have also been trying to seize the opportunity by patenting their intellectual property. Lastly, they have been transforming to fit this new opportunity. All in all, they have a competitive advantage, compared to other companies currently developing autonomous cars. This is mostly due to them being first movers and sensing the opportunity.

On the other hand, Volvo was not very good at sensing the opportunity. They were taken by surprise, when Google launched Google Car. They have since then been good at both seizing and transforming. This is largely due to their launch of Vision 2020 and Concept 26. They are currently working on the largest autonomous car project in Europe and have been making great progress since starting on the project.

All in all, Google was very good at sensing the opportunity of the autonomous car and has continued seizing and transforming since then. Volvo did not sense the opportunity, but has been more aggressively seizing and transforming. This means that Google's competitive advantage has been reduced, while Volvos has been increasing.

The analysis also shows that both Google and Volvo have a strong knowledge resource, which enables them to build dynamic capabilities through knowledge creation processes. This dynamic capability is non-transferable and firm-specific. Which can improve the productivity, but can also help achieve competitive advantage. For both Google and Volvo, it is clear that it has helped with their productivity. They have been able to push through production of an autonomous car very fast.

Co-creation

Through the improved access to information and knowledge, customers are no longer isolated, passive and unaware. Customers have become informed, active and connected with the company. This changes the role of the customer in relation to the company. Co-creation is another aspect of creating value for the firm and the customers, and it might provide companies with a competitive advantage (Prahalad & Ramaswamy, 2004). Prahalad & Ramaswamy (2004) argue that "*The new frame of value creation creates new competitive space for firms. To compete effectively however, managers need to invest in building new infrastructure capabilities, as well as new functional and governance capabilities – capabilities that are centered on co-creation through high-quality customer-company interactions and personalized co-creation experiences"* (p. 12).
Co-creation can be seen as a strategic management tool and approach. Relating the perspective of co-creation to Google and Volvo and their invention of the Google Car and Concept 26, it can be argued that they already try to use co-creation in the way of testing their cars with real customers. In that way Google and Volvo get to know what customers want and what their needs are. This strengthens the value proposition that creates value for the customer and gives Google and Volvo the opportunity to achieve competitive advantage. Google and Volvo could also include their customers in the development process which would give them the opportunity to develop a car that customers in the end actually would buy. Additionally, customers would feel more included in the process and would provide Google and Volvo with loyal customers from the beginning when their autonomous car will enter the autonomous car market. A disadvantage would be in relation to the firm-specific knowledge that both Google and Volvo have. If they invite customers inside, some of

this secret knowledge could leak to other competitors. This would make their dynamic capability of knowledge creating processes less value creating for the company.

Methodology

When analyzing the two business cases, it is important to be critical about the collected data. Most of the data used in this thesis is secondary data, which means it was not collected for this specific case. Primary data could have helped to discover more about the business cases and could have extended the analysis to a more detailed level. However, I do feel that the data collected is enough to analyze the business cases to an extent where a conclusion can be drawn. A longer and more detailed business case description could also have helped in the analysis.

Conducting primary data was a chance to get a more valid and reliable data foundation. The primary data that was collected was through the presentation and Q&A session at Vejdirektoratet. Unfortunately, it did not give me any useful inputs for the analysis, but more background knowledge about the autonomous car research. To make this primary data more useful, I would probably have needed to explain my theories more in-depth and asked my questions, more in an interview-like manner.

The coding process was not as structured as it should have been in relation to the thematic analysis approach. Not using all the steps in the thematic approach made it sometimes difficult to code the data properly. A more structured approach would have made the writing of the analysis and the selection of the quotes and statements easier. Another issue was, that I restructured my analysis, and therefore some of the initial coding could not be used, as other codes were needed. Here, the thematic analysis and coding could have helped from the beginning to get the coding right and find themes.

At the start of this thesis, I expected Google to have a competitive advantage, compared to Volvo. This was highly due to the fact that Google was further in the development and the first movers. Although, the analysis supported my thoughts, it also showed that Volvo is actually gaining rapidly on Google and is closer to its competitor than I thought.

7.2 General Discussion about Autonomous Cars

In this part of the discussion, general things about autonomous cars will be discussed. This makes sense as many issues are still not solved or a solution is difficult to find in regards to the autonomous car.

7.2.1 Issues with Autonomous Cars

Price of a Self-driving Car

There is a lot of discussion about what the price should be for an autonomous car. Many experts predict that these cars probably will be very expensive. The technology in such a car is the most expensive part. The sensor that a Google car have on its roof, is at a cost of about 60.000 Euro, but as an expert says in this magazine, it is not necessary to have such an expensive sensor. Smaller and more inexpensive ones can execute the same job, but they have to be tested more to make sure that a self-driving car not make any accidents with the smaller sensors (Auto Motor und Sport, 2016).

Another article add that a self-driving car will cost around 280.000 Euros, which would not be affordable by most people and makes it a huge challenge for car manufacturers. This price example is taken from the Toyota Prius made by Google. It is also argued that the prices will fall, but this will first be in 2030 and also requires the technology in a self-driving car to get less complex and unnecessary weight have to be minimized (Tannert, 2014).

The price issue is important to look at, because companies such as Google and Volvo want to distribute its self-driving cars to normal customers that cannot afford such an expensive car. Here, it is also important to look at different options within the distribution, e.g. car sharing which is an option or car owning or other combinations of these. Google and Volvo want to make driving safer, but if the self-driving car is too expensive, then it will not be attractive to get. This makes the used technology also an important factor to look at for cars, because the mentioned sensor on a Google Car is so expensive that it probably cannot be used in the future, when they start to distribute the car. This again makes the testing and development of more inexpensive sensors important, because safety is one of the most argued motivations for a self-driving car, and if smaller and more inexpensive sensors are not that good as the expensive ones then a new issue have to be taken care of. The testing of all self-driving cars is very important, but if Google and Volvo do not use the technology which will be integrated in the test cars already now, then it will take longer to get those car on the market and more expensive.

Driver Experience Change

Even if the self-driving car have many advantages as more leisure time, arguments against those self-driving cars are described as driving will get more boring and driver experience will be low (Riener, September 17, 2014).

The driver experience by driving a car will change, the same will the requirement for having a driver license and training to sit in a car that is self-driving. The U.S. state may require chauffeurs to undergo additional instructions. The training should include how to set up a self-driving car, how to deactivate the systems in situations where the self-driving car is not capable of driving itself. If passengers in a self-driving car would need a driver license is not decided yet, this will probably depend on how the cars are invented and what the time from now to their market introduction shows (Harris, 2015b).

For ages, the driver experience have been an important part, when customers chose a car they wanted to own. Many car lovers, like Ferrari or Porsche drivers would probably argue that they would not like to own a self-driving car, because the whole experience to drive it yourself will disappear. For those drivers, the experience to feel free and drive wherever they want to is more important than minimizing pollution or having cars that drive more safely.

Laws and Regulations

If self-driving cars should become reality, it is necessary to change laws and regulations for driving a car, as many countries require to have a human behind the wheel that can control the breaks and everything else.

In the U.S., Google have asked the National Highway Traffic Safety Administration (NHTSA), if it is allowed to have cars that are driven by computers. The answer was that it actually could be possible and therefore the laws in California where Google is placed has been changed to make it a reality. The laws are general international regulations and from 1968, therefore an overhauling is needed. In California, these rules have been regulated and makes it possible for Google and other companies to test self-driving cars, but a report of accidents each month is required (Der Spiegel, 2016). A change in laws and regulations are required when experts say that in e.g. 2040, four out of 10 cars are autonomous (Coffman, 2015).

Liability

Who is to blame and have the responsibility if something happens, like an accident?

Some argues that insurance companies sell the insurance more to the car manufacturer than the current private person that drives the self-driving car. This is the case because private persons will claim the manufacturer, because they were driven by the car and not themselves. This whole issue is again related to the current laws that have to be changed to make it possible to make the car manufacturer responsible for accidents (Die Welt, 2016).

Accidents could happen because these self-driving cars and its technology is not ready for rain, snow or darkness. Rain and darkness makes the sensors kind of blind and dangerous situations could appear. Both Google and Volvo are working on this issue, but a solution is not ready yet (Wiesmüller, 2015).

Hacking Problems

Even if self-driving cars will reduce the amount of accidents, another security issue will rise. This security issue is about hacking of the self-driving car. IT-security is an important topic that have to be taken care of, before these self-driving cars are secure. If a self-driving car’s IT-systems are hacked, the car will be dangerous for itself, but also other cars in the traffic. This makes the hacking issue not only a risk for the IT-infrastructure where all self-driving cars and other normal cars are part of, but also individual cars can be affected and accidents could happen. This whole security issue could make customers afraid, and therefore, trust to these autonomous cars are still something that have to be build up (Balser, 2016).

It is questionable if hacking will ever be possible to avoid. This is in relation to hacking groups that have shown that they can get access even to the most secret and difficult to hack web pages. Therefore, this issue is important to look at for all car manufacturers that are developing a self-driving car. For example, in previous actions executed by hacking groups they were often related to political discussions, which could make the transportation of politicians dangerous.

Challenges for the Car Industry

As mentioned earlier in this research, many car manufacturers are developing autonomous cars, but also unconventional companies are working on a self-driving car such as Google which is used as a business case in this study, but also Uber. These unconventional companies are huge competitors to the more traditional car manufacturers and make the environment around the invention of the self-driving car competitive (Vognsen, 2015). The competition is growing between these two parts, as PriceWaterhouseCoopers argues that less cars are needed when the self-driving car is becoming reality. This has advantages for the environment, but disadvantages for all car manufacturers that are working on the future car (ibid.). In the U.S. the traditional cars might fall about 40% and owning a car could also fall with about 50%, when self-driving cars are on the market (Korosec, 2015).

7.2.2 Disruptive Innovation and Artificial Intelligence

Self-driving Car – Disruptive Innovation?

The discussion about the self-driving car and its degree of innovation is still going on, some argue that it is an incremental innovation, some say it is a disruptive innovation. The scope of this evolution is unforeseeable, therefore, it is difficult to say how these changes will evolve, and this can have influence on industry structures, the working market, business models, value creation, and customer value proposition. Companies work on something radically different, where cars are not owned and driven by a human, but accessible on demand, this will be possible by the introduction of self-driving cars. This perspective is called the disrupter view. Deloitte see four potential future states; incremental change, a world of car sharing, the driverless revolution, a new age of accessible autonomy. The four states depends on the two factors of vehicle control; driver versus autonomous, and vehicle ownership; private versus shared. These four states will happen unevenly around the world, it depends on the population. This makes it difficult for businesses to prepare for just one possible future state, but instead they have to be prepared for each of them. The four different states will become a reality in about 5-15 years around the world (Corwin, Vitale, Kelly, & Cathles, 2015). Christensen was the first to mention disruptive innovation and explained it as "*innovations that create new markets by discovering new categories of customers. They do this partly by harnessing new technologies but also by developing new business models and exploiting old technologies in new ways"* (The Economist, 2015). The opposite as Christensen say is sustaining innovation where existing products are improved. The choice that companies have to make between sustaining and disruptive innovations is called 'innovators dilemma' and is explained by the dilemma that companies need to decide to keep onto an existing market by doing the same and sustain or capturing new markets by using new technologies and new business models which relates to the disruptive innovation. The choice and many decisions is the dilemma that companies have to be aware of (ibid.).

Artificial Intelligence

Another topic that is discussed for the self-driving car is about artificial intelligence. Artificial intelligence appears when computer systems perform the task that, if it was performed by a human, would be regarded as requiring intelligence thinking (Simon, 1995).

The artificial intelligence helps the self-driving car to learn from previous situations, and also thereby make decisions. But an issue could be that no one knows if the decision was the right one. Is the computer better at taking decisions than the human? Ethical and physiological issues can be related to this topic. If the computer have to take a decision e.g. if there is something in front of it and the car cannot stop because it is something that suddenly happened, but if the car should go to the right there was a human, how should the car then decide which human being to "kill"? This is an ethical questions that the software in the car have to decide, but this has been coded by a person.

8 CONCLUSION

This study investigates how Google and Volvo use their internal resources to compete in the emerging market of the autonomous car. To evaluate and compare these two cases, this study first extracts concepts from the theories of resource-based view—valuable, rare, imperfectly imitable, and non-substitutable—and—dynamic capabilities—sensing, seizing and transforming. These concepts are then used in the analysis where statements as well as observations from readings and background knowledge are used to get an understanding of how Google and Volvo uses their knowledge, know-how and self-driving cars to achieve sustained competitive advantage. And to examine if they have built dynamic capabilities in regards to the rapidly changing environment in the emerging autonomous car market.

Previous research shows that internal resources have to be valuable, rare, inimitable and non-substitutable before companies can obtain sustained competitive advantage. The results of this study shows that neither Google nor Volvo has obtained sustained competitive advantage. Notwithstanding, both have temporary competitive advantage, due to their resources being either common or imitable.

Previous research on dynamic capabilities say that it is important to build dynamic capabilities because of the rapid changing environment. This can be done by sensing, seizing and transforming and through these concepts both value creation and value capturing is possible. In regards to

Google, they have been good at sensing the opportunity for developing and introducing their self-driving car, Google Car. Through their internal resources, they have been able to learn and use their knowledge to build dynamic capabilities. Volvo has been good at seizing and transforming, whereas Google has not been as strong.

Both Google and Volvo have set up a vision for their entrance into the autonomous car market. To achieve this vision, they are currently implementing strategies. These strategies are supported by both the companies dynamic capabilities and their internal resources. Therefore the internal resources of the companies are used, to both implement the strategy and differ their version of the automous car, and thereby making them competitive in the market.

8.1 Research Limitations

The methods applied in this dissertation have been suited well for the purpose. However, when specific methods are applied it is important to be aware of their potential impact and limitations on the findings.

Literature review

I conducted a literature review, reviewing 25 articles on dynamic capabilities and resource-based view. Only having this amount of articles can be a limitation to the findings. If I had reviewed more articles within the research field of information technology in regards to dynamic capabilities and resource-based view, it could have provided me with more or other elements and thereby the theoretical foundation and the selected concepts might have resulted in another aspect of these theories. Furthermore, I argued in Chapter 3, I stopped my search for more articles, when I started to return to some of those I already had found. Therefore, I am still convinced that 25 articles provide a valid foundation for the purpose of this dissertation.

Data Collection

In the beginning of this study, the choice of data collection was made. There are many different ways to get data like internal documents, interviews, observation etc., and the reason for only using videos from the internet is that I did not have any connection to Volvo or Google to get primary data in that way. This gave me no real interviews with the two companies that I had chosen as a business case for this research. This is a limitation for this research, as internal documents or an interview with some employees working with the projects of self-driving cars in Google and Volvo could have given me direct answers to my research question and could probably have saved some time. It could also have given me a more in-depth understanding of the companies and this could have led to a more detailed analysis.

Quality of Sources and Validity of Research

The critical assessment of sources and its quality is somehow difficult as many different websites have been used. I tried to use websites that are well known, such as newspapers and magazines focusing on technology. The restriction of only using webpages with documents and videos made the choice of sources difficult, as I had to find information that I could use for the analysis, which made me use all information I could use. In a future research, I should be more critical in the choice of sources as this can have a strong influence on the reliability and validity. This research is made as transparent as possible by writing down each step. This process description could have been more detailed, which will make this research even more reliable because then other researchers could have achieved the same findings by using the same research design. To ensure the validity of this research paper the method of triangulation was used by using primary data and secondary data, in the way of documents, videos, presentation of the master thesis to Vejdirektoratet. This will confirm the data as it is conducted in different ways and can be compared. I think that a real interview with Google and Volvo could have made this research even more valid. This is justified by the fact that some of the videos found on YouTube and TedTalks are also made by others than Google and Volvo, which makes it not a direct source of Google and Volvo. It is therefore, important to be very critical and be objective to make sure to use valid data.

8.2 Further Research

Future studies should collect interviews with project members from the Google Car Project and Drive Me project as primary qualitative data which could give an even more in-depth insights and analysis of this research. The confirmation of the used secondary data would make this research more valid and reliable.

Another suggestion for further research should be to execute the same research, but for other car manufacturers as this research is very case specific and the results are not generalizable to others because of internal resources and dynamic capabilities that often are firm-specific and non-transferable.

Further research could in that way build upon this research and use newly collected primary data and documents to go deeper into the research problem.

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10 APPENDIX

A. Gartner Hype Cycle for Emerging Technologies

Figure 8: Gartner Hype Cycle for Emerging Technologies - http://www.gartner.com/newsroom/id/3114217

B. Overview of the Evolution of the Autonomous Car

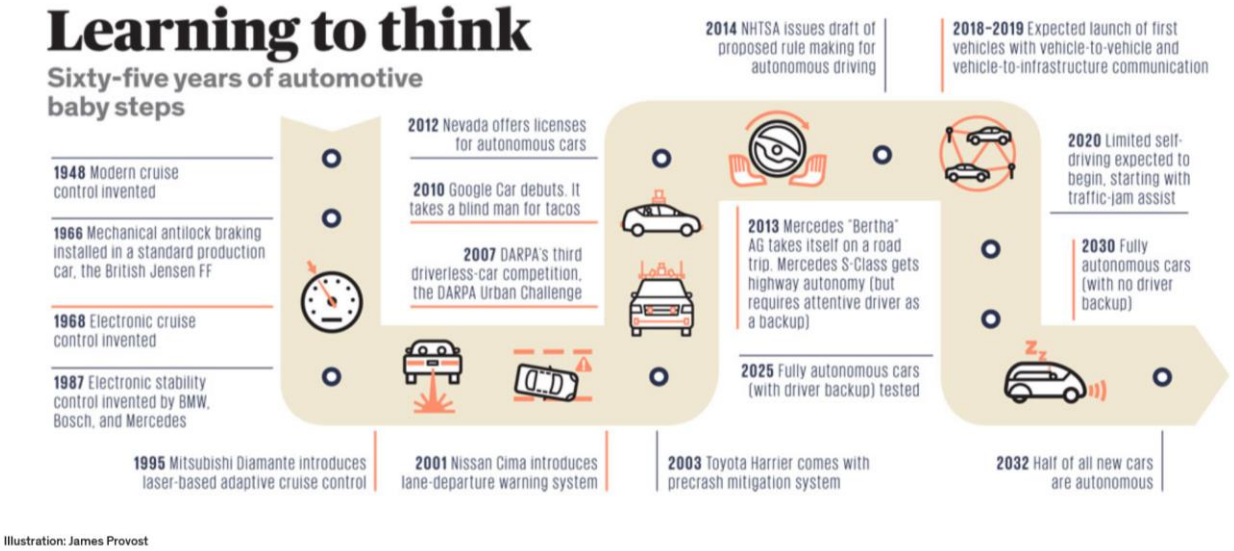

Figure 9: Overview of the Evolution of the Autonomous Car - Source: (Ross, 2014)

C. Levels of Autonomous Driving

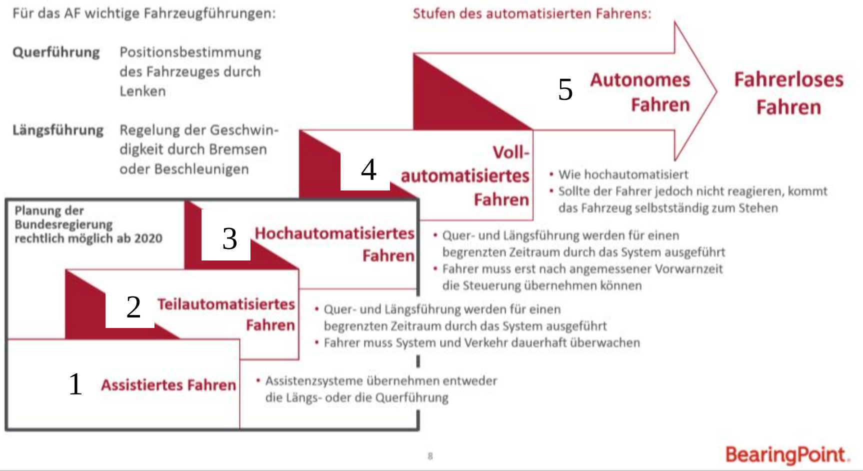

Figure 10: Levels of Autonomous Driving - Source: (Schmid, Heße, & Walther, 2016)