

# Mobility 2.0: Sustainable Business Models for the Automotive Industry

Identifying sustainable sale-of-service mobility business models, utilizing  
alternative powertrains and autonomous technology

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*This master's thesis is carried out as a part of the education at the  
University of Agder and is therefore approved as a part of this  
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## ABSTRACT

The aim of this study is to identify and develop sustainable mobility business models (BMs) for the automotive industry. This is a response to an analysis of the opportunities and limitations of new technology and carsharing BMs occurring alongside emerging industry challenges. The traditional automotive industry BM has remained, thereabouts, unchanged for more than a century. Exploration in this paper determines that to enable future sustainability, industry changes must occur. The current traditional BM is struggling with changing market characteristics and appears inadequate to adopt new environmental technologies (e.g. electric vehicle, autonomous and hydrogen powered cars).

The utilization of a literature analysis approach enables the execution of a highly up-to-date and comprehensive investigation. Literature is used to help identify current industry challenges and present emerging technologies that new BMs need to successfully resolve and utilize respectively. This thesis paper further presents and explores the essential BM theories used in analysis and BM generation. Moreover, there is focus on solving the unsustainability of car ownership, such as by equipping a sale-of-service approach used by carsharing services in order to develop sustainable mobility BMs. The main focus of this thesis is the analysis of opportunities and limitations that identify features necessary for sustainable mobility BMs.

The main findings are two different mobility BMs, which we argue are adequate in concern to the adoption of new technologies and are advantageous in relation to the industry challenges. This thesis presents an autonomous BM that is applicable for urban, densely populated areas, and operates like today's free-floating carsharing services. The second sustainable BM found in this study utilized the sale-of-service characteristics of carsharing, operating in a similar fashion as regular ownership. The analysis is thereby used to develop one BM for autonomous, urban carsharing and one BM for a sustainable ownership-substitute. Both models adopt electric or hydrogen fuel-cell power train technology and utilize the industry challenges as opportunities for growth.

## ACKNOWLEDGEMENTS

We have enjoyed working with this thesis, as we are both interested in cars and the developments within the automotive industry. Throughout this, master study, semester we have never been tired of our assignment or the topic. We have learned and discovered new developments within the automotive industry from day one, and are looking forward to see if our projections come true.

As one will experience when reading this thesis, the automotive industry and the different BM theories are no “narrow road”. We spent a lot of time searching for a reading relevant, and irrelevant, literature. We have dug deep into the automotive industry, business model theories and sustainable technology, and are certain that one will learn from this paper, just as we did while writing it. Writing this thesis have been very challenging, but also extremely rewarding when finalized.

We would like to thank Professor Andreas Erich Wald for helping us throughout this semester, his feedback have been of great value and pointed us in the right direction. The suggested thesis was originally to also cover the whole supply chain, but we wanted to specialize within BM theories, making the best possible predictions about the future automotive BMs. We will also like to thank our good friends Alice Goddard and coach Adam Marshall for their structural help and language guidance. In addition, we would like to thank the University of Agder, Agder Lacrosse, our friends and families.

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## LIST OF ABBREVIATIONS

AV – Autonomous Vehicle

BM – Business Model

CO<sub>2</sub> – Carbon Dioxide

CV – Conventional Vehicle

EV – Electric Vehicle

HEV – Hybrid Electric Vehicle

FCEV – Fuel Cell Electric Vehicle (Hydrogen)

GHG – Greenhouse Gas

ICE – Internal Combustion Engine

PwC – PricewaterhouseCoopers

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## 1.0 INTRODUCTION

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### 1.1 BACKGROUND

For the last 100 years the automotive industry has been using, more or less, the same BM for the same product (Holweg, 2008). Advancements in technology, engineering, materials and performance have continuously led to better, faster, smarter, and safer cars. Similarly, automakers have made changes to its production methods, expanded into new markets, introduced lean production, expanded model range, and facilitated for personal customization (Holweg, 2008; Kessler and Stephan, 2013). While these developments are many, industry experts like Kevin Kerrigan, (SVP, Automotive Office) consultants at PwC (2014) state that the industry will see more changes in the next 10 years, than it has seen during the last 100 years. During the last 100 years, automotive BMs have only experienced minor changes to their main objective – selling their vehicles (product) to consumers (car owners) (Wells, 2004; Holweg, 2008; Wells, 2013; Abdelkafi, Makhotin & Posselt, 2013; Kessler & Stephan, 2013). Recent research suggests that the automotive industry is struggling to adapt to recent market changes (Holweg, 2008; Abdelkafi, Makhotin & Posselt, 2013).

*"The global auto industry will continue to grow and the reason it will grow is you will see the global middle class double in the next 15 years,"*

- Mark Fields, President and CEO of Ford Motor Company, 2016

Since the financial crisis in 2008, the automotive industry is again seeing sales and production growth, record sales in the US and overall higher profits, especially in North American and Chinese markets (Cutcher-Gershenfeld, et al., 2015; Phillips at Automotive News, 2016; ACEA April, 2016; Wissmann, 2016). In KPMG's *Global Automotive Executive Survey 2015* most of the respondents stated that downsizing, improving efficiency, and focus on emerging markets was the key trend for 2015 and the near future.'

*"As we stand back and we look at the overall approach, it's one in which I think you will see some parts of the world actually tighten regulations on 'personal use vehicles' in down town city areas."*

- Mark Fields, President and CEO of Ford Motor Company, 2016

However, markets in Europe, urban markets in North America and some Asian markets are maturing, and will face saturated demand and increasing pressure to reduce congestion in urban areas. In these markets, manufacturers are faced with over-supply and reduced profit

margins as sales-growth declines (Holweg, 2008; PwC, 2014). Further, environmental concerns have forced limitations on fuel and resource consumption and led to the introduction of new power train technologies (Wells, 2004; Canzler & Knie, 2009; Wells, 2013). The automotive industry appears to have trouble adapting to recent market changes and emerging technologies, which will require their existing BM to change as they no longer can remain dependent on continued sales growth of personal vehicles (Christensen, 1997; Margretta, 2002; Wells, 2004; Kaplan, 2012; Abdelkafi, Makhotin & Posselt, 2013; Wells, 2013). In this thesis we argue that the current automotive BM is not sustainable in mature markets, and therefore unable to cope with changing technologies and changing market demands and characteristics.

The core features of the automakers' BM were developed more than a century ago by the likes of Henry Ford (Ford) and Albert Sloan (General Motors), when mass-production, growth, and increased sales were important objectives (Holweg, 2008). The existing BM continued to develop without environmental concerns in mind. Emission-free power train technology has struggled to gain traction as the current BM was developed for internal combustion engine (ICE) vehicles, and thus provides the most customer value when used selling these traditional vehicles (Abdelkafi, Makhotin & Posselt, 2013; Wells, 2013). The thesis further argues for a new radical BM innovation in order to adapt to the many changes facing the inflexible, traditional automotive BM (Chesbrough & Rosenbloom, 2002; Johnson & Suskewicz, 2009; Kley et al., 2011; Wells, 2013).

Our research found that carsharing services provided a better match with emerging market challenges and identified emerging technologies, compared to the current BM and structure, and that sustainable BMs have to be introduced as an alternative to car ownership in mature markets (Kessler & Stephan, 2013; Abdelkafi, Makhotin & Posselt, 2013; Shaheen and Cohen, 2013). Carsharing BMs are based on mobility and accessibility through a "sale-of-service" approach in contrast to the "sale-of-product" model that remains prevalent in the automotive industry BM (Abdelkafi, Makhotin & Posselt, 2013; Shaheen & Cohen, 2013). Carsharing BMs are found to provide larger advantages in mature markets, and can be used as a foundation for the development of sustainable mobility BMs for the future. Moreover, carsharing enables mobility providers to sell miles, rather than products, and therefore diminish the industry reliance of continuous sales growth (Kessler & Stephan, 2013). In this thesis *carsharing* is defined as short term access to a vehicle "*owned by another person or entity in exchange for an agreed monetary payment*" (ACEA, 2014). Ride-sharing services or

Transport Network Companies (TNCs) like Uber and Lyft are beyond the scope of this thesis, but their successes are perceived to be relevant to these types of services as well.

*“The automotive industry is a century-old ecosystem being ogled by outside players hungry for a slice of a \$10tn mobility market (10tn miles traveled per year \* \$1/mile). Many want in. It’s just beginning. And it won’t stop”.*

- Adam Jonas at Morgan Stanley, 2015

This thesis presents an analysis of carsharing models, industry challenges, and emerging technologies, in order to identify the potential opportunities and limitations of adopting these technologies and models, and to use the findings to develop two sustainable mobility BMs. Throughout this thesis we analyze relevant research literature, BM theories, industry reports and market data in order to create a comprehensive understanding of the future of the auto industry, in order to make suggestions for future sustainable mobility BMs, which we have defined as *Mobility 2.0*.

This thesis is solely based on available data, research literature and automotive market reports, which enables it to be as up to date and relevant as is possible. The findings provided should not be considered revolutionary for any industry expert.

This thesis will provide a comprehensive and precise foundation for further research on the key ideas and main findings of this thesis. We decided to perform a literature analysis on this highly dynamic topic, as it is developing daily, and no thorough study had been performed that has combined sustainable BMs (with a clear definition of sustainability and barriers to growth) with new technology adaptation and BM innovation in order to overcome rising challenges in the automotive industry (Wells, 2013).

After discussing with our thesis supervisor, we decided that adopting a case or survey approach would be inappropriate, as we would be limited by a small sample size in investigating a highly dynamic and comprehensive subject. By choosing a literature analysis approach when performing this study on the automotive industry and BMs, we would be able to create a study that provided both a connection between the current changes of the automotive industry and new BMs, and an understanding of structural growth and sustainability barriers. In order to develop a thesis that would be applicable and practical to other stakeholders and researchers, we finally chose to perform a literature analysis. We have

throughout this study followed the developments in the automotive industry on a daily basis, and tried to base our findings on the most current industry developments.

For the sake of reducing complexity, we define *the automotive industry* to include mainly personal car manufacturers. Mobility/carsharing providers are also included in the designation *the automotive industry*, but only at a later stage in the thesis. Suppliers of components, technology and materials are primarily not included in this thesis, unless specifically mentioned. Nevertheless, we assume that the findings in this thesis will be applicable, to some extent, to all automotive industry stakeholders.

## **1.2 PURPOSE**

The main focus of this thesis is to develop sustainable mobility BMs for the automotive industry, by adopting emerging automotive technologies and access-based business models to overcome identified automotive industry challenges.

## **1.3 STRUCTURE**

This thesis is organized in five main chapters. Chapter one serves as an introduction, where we present the background for the study and introduce the reader to the object of this thesis.

In chapter two we have analyzed the current state of the *automotive industry*, focusing on identifying changes and issues facing the automotive industry. Further, we present arguments stating the current structure and BM of the automotive industry limits its ability to change and cause changes in the environment to become challenges. By analyzing available literature and market trends, we identify four challenges and four emerging technologies, forcing the automotive industry to reassess its ways.

In chapter three we present *business model* theories and an overall overview of the BM of today's automotive industry. The two subchapters in this chapter provide the theoretical framework on BM theory used in chapter four. The chapter further describes the importance of BMs and BM innovation and also presents theories and tools than can be used in order to generate BMs.

Chapter four, *Automobility 2.0*, initially present benefits and sale-of-service mobility services. We further present a thorough overview of modern carsharing services and categorize the different carsharing services into three types. Within the three categories we further identify different carsharing BMs. We continue by analyzing four different carsharing BMs; identifying the potential opportunities and limitations that occur when the carsharing BMs are faced with the challenges and emerging technologies identified in chapter two. Chapter four

ends with a presentation and description of two mobility BMs developed by the findings of chapter 4.4.

Chapter five serves as the conclusion of this thesis, with a discussion of the main findings. In chapter 5.1 we continue by discussing and presenting ideas to which companies, existing or new entrant, that can adopt the BMs presented in chapter 4.5. Subchapter 5.2 presents a concise conclusion of the study. Chapter 5.3 presents research limitations alongside a more thorough explanation of the necessary assumptions made. Finally, subchapter 5.4 outlines suggestions for future research based on the findings of this thesis.

## 2.0 THE AUTOMOTIVE INDUSTRY

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*“The desire for change arises from a dissatisfaction with the present”*

- Paul Nieuwenhuis & Peter Wells, 2003

### 2.1 CURRENT SITUATION AND INDUSTRY CHALLENGES

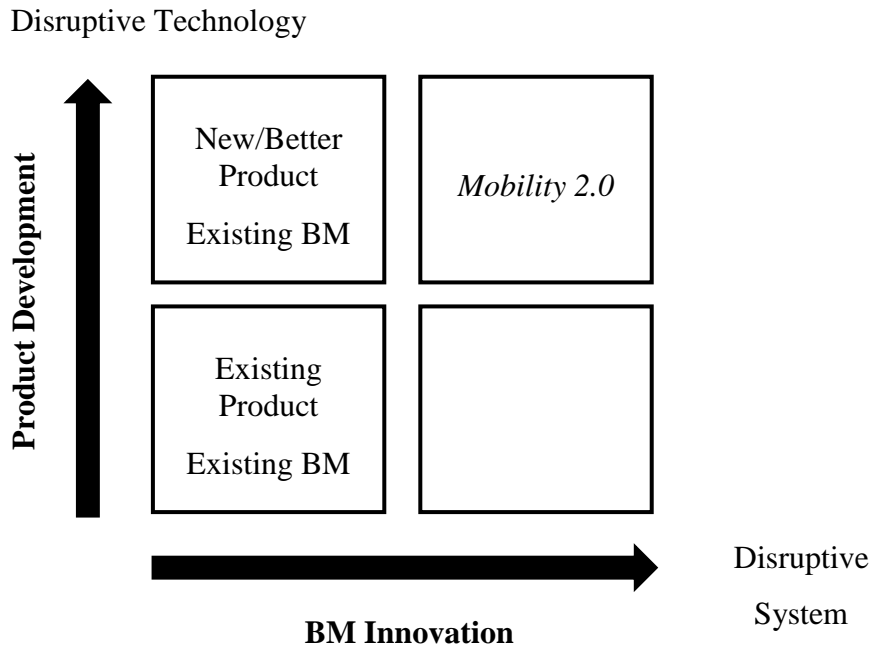
What is unsatisfactory about the present automotive industry? In this chapter we are going to present literature findings on the current state of the automotive industry. Primarily, the present findings on how automakers are operating and how they are adjusting to the current changes influencing the industry will be explored. During our study of available literature, we found two main issues, that are actively affecting the automotive industry;

- 1) Sustainability issues with the way the automotive industry is run today.
- 2) Four main industry challenges that are forcing the automotive industry to change.

#### **Sustainability Issues in the Automotive Industry**

Our study of available literature suggests that the automotive industry is not fully focused on necessary BM innovation, and that it is more concentrated on performing *product development* and *service expansion* in order to face future industry challenges (Nieuwenhuis & Wells, 2003; Holweg, 2008; Canzler & Knie, 2009; Abdelkafi, Makhotin & Posselt, 2013; Kessler & Stephan, 2013). As illustrated in **figure 1** below, the automotive industry cannot achieve *Mobility 2.0* when product development is not accompanied by equivalent BM innovations or vice versa.

**Figure 1: Product Development**



We have found that the current structure of the automotive industry is a cause for concern (Nieuwenhuis & Wells, 2003; Holweg, 2008; Wells, 2013). While the industry is most likely facing drastic changes in the next couple of years (reinventing its BM and product development), we can still see commitment to century old BM characteristics inherited from the industry’s founding companies (Nieuwenhuis & Wells, 2003; Wells 2004; Holweg, 2008; Wells, 2013).

Many researchers argue that the industry’s traditional organizational structure and BM is no longer viable, and this is the reason why the automotive industry has and will continue to struggle in the future (Nieuwenhuis & Wells, 2003; Canzler & Knie, 2009; Holweg, 2008; Wells, 2013; Abdelkafi, Makhotin & Posselt, 2013; PwC, 2014;). These researchers point out that the current structure and century-old BM of the automotive industry is not sustainable in markets faced with the industry’s new challenges (Nieuwenhuis & Wells, 2003; Holweg, 2008; Canzler & Knie, 2009; Wells, 2013; Abdelkafi, Makhotin & Posselt, 2013; Wells & Nieuwenhuis, 2015). Changing market characteristics and new technologies are going to change the industry (Holweg, 2008; Wells, 2013; PwC, 2014). However, the current BM is inadequate to cope with these changes in technology, and is already at the root of many of the industry’s current issues (Holweg, 2008; Abdelkafi, Makhotin & Posselt, 2013; Wells, 2013).

Furthermore, increased globalization and fragmentation of markets have been the industry's short-term solutions to decreased growth and shrinking profits, while their BM and structure are not flexible enough in the long term to cope with these changes (Holweg, 2008; Wells, 2013; PwC, 2014). The inflexibility of the current BM and structure limits the automotive industry's ability to efficiently use and implement innovative technologies that can improve long-term results (Holweg, 2008; Abdelkafi, Makhotin & Posselt, 2013). The industry incumbents are instead continuing with the traditional BM, and are moving on by making minor improvements, short-term adjustments and adding services that are close to their experience and favor the companies' familiar capabilities (Christensen, 1997/2001; Nieuwenhuis & Wells, 2003; Holweg, 2008; Canzler & Knie, 2009; Kessler & Stephan, 2013; Bohnsack, Pinkse and Kolk, 2013; Wells, 2013). In KPMG's *Global Automotive Executive Survey* (2015) the survey reveals that the majority of automotive executives consider growth in emerging markets as the number one trend towards 2025. The survey furthermore argues that only a minority of automotive executives consider alternative powertrain technologies, connectivity and mobility services as the most important trend to focus on in the next ten years (KPMG, 2015).

Kessler & Stephan (2013) further show that incumbent automakers are adding more services to complement their current product offerings. In addition to increased personalization options (Holweg, 2008; Kessler & Stephan, 2013) and increased model range offerings (Holweg, 2008; Roland Berger, 2011; Wells, 2013), today's automakers are adding financial, advisory, and maintenance and repair services to support the car sales revenue stream (Kessler & Stephan, 2013).

Today, car manufacturers rely on aftersales (parts, services etc.) and financial services for profits (Nieuwenhuis & Wells, 2003). As much as 18% of the profit comes from part distribution and 14% from car financing while new car retailing only provides 3% of the total profit (Nieuwenhuis & Wells, 2003). By continuing to operate with the same BM introduced by Henry Ford and Alfred Sloan (GM) a century ago, the automotive industry is facing continuously shrinking profit margins, oversupply and increasing production complexity (Nieuwenhuis & Wells, 2003; Holweg, 2008; Canzler & Knie, 2009; Wells, 2013; Wells & Nieuwenhuis, 2015). Car manufacturers' traditional core competence is to manufacture and sell vehicles. However, increased globalization and competition has made profits smaller due to increased competition and decreased quality differences (Holweg, 2008). The reduced



profit margins forces manufacturers to develop new ways of increasing revenue streams from their current BM (Nieuwenhuis & Wells, 2003; Wells, 2004; Holweg, 2008).

### **Challenges of the Automotive Industry**

In this subchapter, the available literature on automotive BMs and the structure of the automotive industry, in order to identify current and future challenges. We have studied and identified challenges ahead for the automotive industry, these will be taken into consideration when we later identify sustainable mobility BMs in chapter four. By studying and analyzing a great number of available studies on the current situation and future challenges of the automotive industry, we have identified a pattern of challenges, and classified four main challenges that are forcing change in the automotive industry in order to facilitate for continued growth in mature markets.

#### **Maturing and Saturated Markets**

First, during our work with the literature we identified *maturing and saturated markets*, as a current and future challenge for the automotive industry (Nieuwenhuis & Wells, 2003; Holweg, 2008; Wells, 2013; PwC, 2014; Wells & Nieuwenhuis, 2015).

Although global car sales have continuously grown over the last 50 years, and many manufacturers are again seeing sufficient profit margins, the overall growth in car production has been just below 2% since 1975 (Holweg, 2008; PwC, 2014). The traditional automaker BM was developed a century ago, operating in an environment where the automotive industry was providing vehicles to a continuously developing world with emerging markets (Nieuwenhuis & Wells, 2003). In contrast to markets 100 and 50 years ago, most developed markets (Europe, urban North America, Japan and South-Korea) today are saturated or maturing and the literature argues that a different BM is required in order to succeed in these conditions (Nieuwenhuis & Wells, 2003; Holweg, 2008; Wells, 2013; PwC, 2013; Abdelkafi, Makhotin & Posselt, 2013).

Researchers argue that, in reality, automakers are fighting for market share in mature and saturated markets, rather than long-term market growth, whilst using an obsolete BM developed to provide and sell vehicles to unsaturated and high-demand markets (Holweg, 2008; Wells, 2013; PwC, 2014). Holweg (2008) argues that success in mature and saturated markets is not met by scale or unit cost alone, and advocate for automakers to “*sense trends in the market, and align its product range that determines success*”. Holweg (2008) and Canzler & Knie (2009) further argue that continuing to ignore the trends of the current, and future,

market challenges and by remaining with their current mass-production and market-share driven BM will not lead to long-term success.

In an effort to increase market share, car manufacturers are reducing the number of platforms, while increasing the total number of models that they offer (Holweg, 2008; Roland Berger, 2011; Wells, 2013; KPMG, 2015). By doing this the companies can target more customer segments and still keep their costs down. GM moved from 30 platforms in 2010 to 26 in 2015 and are planning to move to only four flexible base models by 2025 (PwC Auto Trends, 2015). Increased model offerings cause added complexity in marketing and production systems, lower profit margins and increased costs for the company, although this is outweighed by increased sales volume and cost-savings from sharing components between cars and platforms (Wells, 2013; PwC Auto Trends, 2015). More common components mean fewer suppliers and the ability to achieve more efficient economies of scale (Wells, 2013).

Manufacturers have also been gaining market share by introducing vehicles with features appealing to a certain niche. For example, with manufacturers like BMW, Dacia and Tata have been successful by introducing vehicles like the crossover, coupe-styled BMW X4 and X6 SUVs, and no-frills concepts like Dacia Logan and Tata Nano (Holweg, 2008; Roland Berger, 2011). Manufacturers have also been appealing to fuel-conscious customers by competing on fuel-economy. This has grown into a very important and competitive market for many manufacturers. However, some manufacturers like Volkswagen (VW) and Mitsubishi have been revealed to cheat on their emissions tests in order to gain market share (Harry Kretchmer, 2015). The exposures have led to billion-dollar lawsuits, buy-back programs, and are viewed as a worldwide scandal, seriously harming the credibility and sales of manufactures like VW, Mitsubishi, Nissan, Renault, and Mercedes (Kretchmer, 2015).

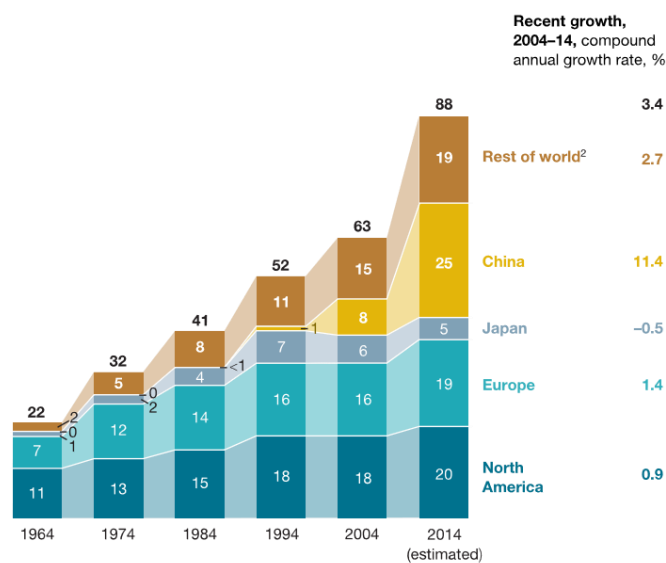
Due to the inflexibility of manufacturers' production adjustment systems and BM, it is easier for car manufacturers to increase production rather than reducing it (Holweg, 2008). Moreover, the production time required between sales and delivery is forcing car manufacturers to predict sale numbers years ahead of delivery, resulting in over-capacity (Nieuwenhuis and Wells, 2003; Wells, 2004; Wells, 2013). The inflexible structure might, in the case of a downturn, result in over-capacity and a rapid depreciation for new cars (Nieuwenhuis & Wells, 2003; Holweg, 2008). Holweg (2008) found the global overcapacity to be as significant as 20 million units. Global overcapacity in 2014 was estimated to be around one million vehicles based on data from the International Organization of Motor

Vehicle Manufacturers (OICA) and similarly to be 1,3 million using data from European Automobile Manufacturers Association (ACEA). Increased market fragmentation and globalization makes this process even more difficult as the fragmented customer groups have different preferences and needs, which reduce the effectiveness of production (Niewenhuis & Wells, 2003). Car manufacturers are then faced with two choices; produce fewer cars and focus on selling the whole production volume, which risks losing potential market share and profit, or produce a large quantity of cars and face the risk of unsold cars, which will reduce profit margins.

Wells (2013) argues increased globalization of markets, increasing scale advantages and increasing model diversity will lead to continued over-supply, increasingly shorter model life cycles, increased production and sales complexity, and higher competition. However, the automakers will inevitably run out of strategic options to sustain market share while using the current BM, and might be painfully forced to change (Cooper, 2011; Wells, 2013).

Moreover, PwC (2014) and KPMG (2015) argue that while western markets are saturated or maturing, Asian countries like China and India are the final markets where automakers can expect significant growth opportunities with their current BM (See **Figure 2**). This means that European, North- and South American markets, in particular, , are becoming saturated and that the automakers need to launch innovative products and make changes to their BM in order to create value in these markets (Abdelkafi, Makhotin & Posselt, 2013).

**Figure 2: Car and Truck Sales by Location, 1964-2014**



(Source: Mckinsey.com, 2014)

### **Environmental Pressure**

The second challenge that will have a great impact on the automotive industry, and which will impact fossil fuel vehicle automakers in the future is increased *environmental pressure* (Nieuwenhuis & Wells, 2003; Canzler & Knie, 2009; Shaheen & Cohen, 2013; PwC, 2014).

Nieuwenhuis & Wells (2003), Holweg (2008), Canzler & Knie (2009), and Roland Berger (2011) state that increased environmental pressures on the industry by customers, governments and international organizations are forcing the automotive industry to become more environmentally friendly. They are increasingly focused on reducing its carbon dioxide (CO<sub>2</sub>), greenhouse gasses (GHG) and toxic emissions. As governments in Europe, China and the US are increasingly implementing strict emission standards for vehicles, the manufacturers need to innovate and implement new technologies in order to remain competitive (Canzler & Knie, 2009).

The conference “Green Solutions – Future Transport Services” was held on the 21<sup>st</sup> of April 2016, in Oslo, Norway, and the main topic of this conference was to discuss the worldwide transition towards green sustainable mobility. Despite previously mentioned issues with emission test cheating, governments and the automotive industry understand the need to work together in order to develop and facilitate a wholesome framework for an accelerated environmental mobility. This means providing sustainable incentives for emerging technologies like EV and FCEV (hydrogen), and sharing/access services like Uber, Lyft and Nabobil, instead of trying to ban and over-regulate them (Canzler & Knie, 2009; Olsen, Solvik, 2016). Another important issue discussed at the conference was the introduction of international regulations and legislations. These enable production and sales of new products and other disruptive services and thereby reduce the lag between technology development and real-world implementation (Foxx, 2016).

The phrase *new technologies* in this subchapter, describes more than simply alternative powertrain technologies, it also describes changes and innovation in production materials and durability. Reduction in weight, by using innovative materials like carbon and aluminum, will further reduce CO<sub>2</sub> emissions (Roland Berger, 2011).

### **Changing Customer Demands and Needs**

Third, *changing customer demands and needs* were found to limit the future growth potential of the industry, when operating with the current BM (Canzler & Knie, 2009; McKinsey, 2012; Wells, 2013; Shaheen & Cohen, 2013; PwC, 2014).

Canzler & Knie (2009), Wappelhorst et al., (2014) and KPMG (2015) further argue that although car access, a driver license and car ownership is still important among most gender groups, young adults in urban areas are changing their transportation patterns. Whilst car travel will remain the main mode of transportation and to own a car will still be important, increased use of intermodal transportation and less driving are emerging transportation patterns among young adults (Canzler & Knie, 2009; Wappelhorst, et al., 2014). These findings are similar to findings by McKinsey (2012) that performed a survey in Germany, uncovering that young adults still strive for car ownership, but were more open to other mobility services like carsharing. The same survey also suggested that the growth of carsharing services and alternative transportation could postpone car-purchasing (McKinsey, 2012). These arguments are further supported by findings by KPMG (2015). Finally, the survey (McKinsey, 2012) suggested that consumers put a higher emphasis on media integration and innovative digital features, which would make their transportation easier and more convenient. These arguments are further supported by Roland Berger Consulting (2011) that advocates the importance of e-commerce and digitalization, in addition to providing customers with digital services and connectivity within the automotive industry.

*“Economic uncertainty, rising energy and private auto ownership costs, and efforts to increase vehicle efficiency and reduce greenhouse gas (GHG) emissions”*

- Shaheen & Cohen, 2013

Shaheen & Cohen (2013) identified the factors above as reasons for concern that impact consumers to find new alternatives to, and reduce, personal vehicle ownership. Shaheen & Cohen (2013) and Wappelhorst et al., (2014) are arguing that many consumers are attracted by mobility services, which can provide them with mobility access without the responsibilities and costs of traditional car ownership. We will provide further arguments for the growth of carsharing concerning environmental pressure in chapter four.

*“To avoid being innovated out of relevance, suppliers should look ahead to future developments in areas like new powertrains, new materials and new vehicle concepts or architecture”*

- PwC, 2014

Similar with previous findings, a market report by PricewaterhouseCoopers (PwC) (2014) identifies changing consumer expectations, the emergence of new technologies, and pressure to

innovate, as three of the major challenges in the automotive industry today. PwC (2014) further argues that manufacturers have to provide innovation to their current products and BMs in order to meet the customer demands of the future.

### **Accelerated Urbanization**

The fourth, and last challenge we have identified and that will be included in our analysis, is *accelerated urbanization*. Urbanization leads to increased congestion and greater environmental issues (Nieuwenhuis & Wells, 2003; Rydén & Morin, 2005; Holweg, 2008; Canzler & Knie, 2009; Shaheen & Cohen, 2013; PwC, 2014; Shaheen, Chan & Micheaux, 2015).

How many vehicles can the planet handle? When Henry Ford suggested that every person should own a car in the 1930s, he probably did not take into account the rapid population growth the following 100 years. According to data presented by Wardsauto (2010) the world's vehicle population surpassed 1 billion units in 2010. However, the average usage of a car is less than 1 hour a day (Hjorthol, et al., 2014; Morgan Stanley, 2015). Shaheen & Cohen (2013) and Martin, Shaheen & Lidicker (2010) have been studying the impact of carsharing and discovered that one carsharing vehicle could remove as many as 9 - 13 privately owned vehicles from the road (more about this in chapter four, see **table 5**).

Findings by PwC (2014) match estimates made by the United Nations (UN – DESA, 2012), which estimates that the world's expected population growth by the year of 2050, 2,6 billion, will be absorbed into cities. By 2050 the world's population will almost double, and that this entire population growth is going to gravitate towards the world's largest cities. It should be argued that with a population of 6 billion people, an increase of 2.6 billion people combined in urban areas, will have dramatic consequences and threaten today's urban travel patterns (Shaheen, Chan & Micheaux, 2015).

## **2.2 EMERGING TECHNOLOGIES**

In this subchapter we will present some of the most prominent technologies and products emerging within the automotive industry today. Vehicles have been equipped with an ICE for more than a century. During the last decade electric vehicles have been reintroduced as a viable powertrain technology. Hybrid electric vehicles (HEVs) are gaining strong market penetration in several markets, as consumers opt for environmental friendly engine alternatives. Furthermore, we will present hydrogen fuel cell vehicles, which are considered the most recent powertrain technology of the future. Connectivity and self-driving vehicle

technology will also be presented in this subchapter, as these are technologies that will have a disruptive impact on today's automotive industry and BM (Greenblatt & Shaheen, 2015; Anderson, et al., 2014; KPMG, 2015).

### **Electric Vehicles**

There are currently two technologies and concepts that exist within the EV scenario: the fully electric vehicle and the hybrid electric vehicle (HEV) (Canzler & Knie, 2009). The evolution of the EV started with the development of fully electronic, compact urban vehicles, while HEV technology has been evolving and implemented into long-range sedans since the early 2000s (Canzler & Knie, 2009). In this subchapter we present both the EV and HEV, with a large emphasis on plug-in EVs. The development and introduction of EVs allows for zero emission mobility and is considered a disruptive technology compared to the traditional petroleum fueled ICE vehicle, whereas HEV is more of a sustaining improvement of existing vehicles.

#### **Electric Vehicle**

The electric vehicle (both EV and HEV) is the most prominent alternative drive train technology available in the automotive industry today, and is expected to dominate the innovation of the automotive industry in the near future (Abdelkafi, Makhotin & Posselt, 2013). The growth of EVs since 2010 has gone from below 100,000 sold EVs to above a million within six years (Lutsey, 2015; Statista, 2016). EVs are powered by an electric motor, which uses onboard batteries for energy storage (IEA, 2009). The batteries within the car are charged from the electricity grid, using home, public, or private charging stations, such as Tesla's *superchargers*. Batteries can also be charged by brake energy recuperation (IEA, 2009; Williamson, 2013).

The foremost benefit of an EV is zero vehicle emissions of GHG or air pollutants (IEA, 2009; Williamson, 2013; Hjorthol, et al., 2014). Studies conducted by the International Energy Agency (IEA) (2009) and Williams (2013) showed that compared to traditional ICE-vehicles, EVs are also three times as energy efficient (*drive train efficiency up to 90% of input*), make very little noise, and match or exceed ICE-vehicles in crash-safety tests. The same studies also shows that EVs provide an improvement in handling and increased performance (torque → acceleration) compared to conventional vehicles (CVs). The added safety and performance features are a consequence of EVs' structural design and high efficiency of the electric drivetrain (Orsato and Wells, 2007; IEA, 2009; Williamson, 2013). Data estimates from the

US Department of Energy's fueleconomy.gov (2016) finds that the annual fuel costs of EVs are significantly lower than that of an ICE-vehicle.

The most substantial limitation of an EV is the limited range compared to traditional ICE-vehicles. As **table 1** indicates most EVs today have a range lower than 100 miles. Compared, the minimum range for ICE-vehicles is 310 miles (IEA, 2009), which means that traditional ICE-vehicles are more competitive on range.

Unfortunately the charging infrastructure is still in its development phase and the charging network and charging technology are still inadequate compared to the fueling network and technology available for CVs (Bohnsack, Pinkse & Kolk, 2013). Today's limited range and lack of charging infrastructure makes people concerned about long range journeys, although previous studies show that most commuter and daily journeys are much shorter than the range limit of the EVs (Canzler & Knie, 2009; Boulanger et al., 2011; Williams, 2013; Hjorthol, et al., 2014; Hjorthol, et al., 2016). Canzler & Knie (2009), further argue that one should not compare EVs to all the benchmarks of a CV, as the EV's capabilities are more than adequate for many scenarios where long-distance travel is not necessary, as in intermodal transportation, or urban usage.

In Electric Vehicle Initiative's (EVI) publication *Global EV Outlook* (2013) EVI argue that the range limitations of EVs should not be a concern for most drivers, as *range expectations* exceed *actual average driving needs*. The argument is based on a study of which surveyed the average American daily vehicle distance travelled. The average American daily vehicle distance travelled per person was 28,5 miles and a per trip distance of 9 miles. Most EVs today have sufficient range to meet a distance of 9 miles per journey or 28,5 per day. Wappelhorst et al., (2013) presents similar findings in "*Flexible carsharing - potential for the diffusion of electric mobility*". Further, Hjorthol (2015), from the Norwegian Institute of Transport Economics, presented similar findings at an international electro-mobility conference in Oslo, 2015, where Hjorthol stated that:

*"We/people believe that we travel longer (than we actually do)"*

- *Randi Hjorthol, 2015*

Hjorthol (2015) continued by presenting numbers from a national travel behavior survey from 2009, where the survey found that the average travel length of car trips was 8.45 miles, and the total travel length per car per day was on average 30.4 miles (Hjorthol et al., 2014). This is



well within the range limits of most EVs. The survey also found that those with travel distances over the range limit of many EVs would have opportunities to recharge during the day (e.g. at work or at home) (Hjorthol et al., 2014; Hjorthol et al., 2014; Hjorthol, 2015). The Norwegian and American surveys presented can be used to argue that there should be no EV range concerns for most drivers

Some of the drawbacks of EVs are as follows. Batteries used in EVs are also heavy, which results in increased weight on long range vehicles (IEA, 2009). In addition, the batteries used in today's EV and HEV are very expensive compared to the price of the whole car (from *a third, to more than a half* – EVI, 2013) and the expensive batteries need to be replaced as current EV batteries have a limited lifespan (Williamson, 2013; Hjorthol et al., 2014). Tesla Motors are providing battery warranty for a period of 8 years or 125 000 miles, whichever comes first (TeslaMotors, 2012). This means that consumers are reluctant to take on the financial costs and risk of an EV, as the total cost of ownership and initial purchase price is usually higher than CV equivalents in the first place (EVI, 2013; Abdelkafi, Makhotin & Posselt, 2013; Hjorthol et al., 2014).

Deriving from the exploration of the advantages and clear disadvantages of EVs is a supporting argument that there is a need for new BMs in order to profit from electric power train technology (Canzler & Knie, 2009; Abdelkafi, Makhotin & Posselt, 2013). As presented in IBM's study "*Advancing Mobility*" (2010), the need for BM innovation has been identified and accepted by many of the industry's executives (Canzler & Knie, 2009; IBM, 2010; Abdelkafi, Mokhatin & Posselt, 2013). Many studies argue that EVs are advantageous and provide sufficient value for most carsharing BMs (Bohnsack, et al., 2013; Abdelkafi, Mokhatin & Posselt, 2013; Wells, 2013; Hjorthol, et al., 2015).

**Table 1: Electric Vehicle from Car Manufactures, 2010-2017**

<b>Manufacturer</b>	<b>Model</b>	<b>Introduction Year</b>	<b>Range (approx. Miles)</b>
BMW	i3	2013	81* ( <i>range extender 150*</i> )
Chevrolet	Spark EV	2013	82*
	Bolt EV	2017	200**
Fiat	500e	2015	84*
Kia	Soul EV	2014	93*
Mercedes	B-Class E-drive	2014	87*
Nissan	Leaf	2010/2011	84/107*
Tesla Motors	Model S	2012	240-270*
	Model X	2016	237-257*
	Model 3	2017	215*
Toyota	RAV4 EV (2. Gen)	2012	103*
Volkswagen	eGolf	2015	83**
	eUp!	2013	93**

\* EPA estimated range (U.S. Environmental Protection Agency)

\*\* Manufacturer estimate range

\*\*\* NEDC (New European Driving Cycle)

### Hybrid Electric Vehicles

As current EV battery technology is still immature, expensive, and limits the range of full EVs, HEVs can provide sufficient energy (from two engines) to meet most range and torque standards set by CVs (Williamson, 2013). As of today, plug-in hybrids are attracting more customers and generally outsell full EVs in most markets (KPMG, 2015).

HEVs are vehicles that are powered by an electric engine usually in combination with a traditional petroleum, or diesel, engine and an electric motor (Williamson, 2013). The different engine technologies work together and the result is a low-emission vehicle with electric driving capabilities, supplemented by an ICE in order to deliver the range requirements of CVs (Williamson, 2013). The electric motor in a HEV contributes to reduced GHG emissions and in combination with a smaller, fuel-efficient ICE it also reduces fuel consumption (Williamson, 2013). The characteristics of an HEV are similar to those of a CV, especially range and are therefore considered the most practical and efficient substitute for CV in the near future (Williamson, 2013).

**Table 2: Electric and Total Range of Hybrid Electric Vehicles**

Brand	Model	Range: Electric miles	Range: Total
Chevrolet	Volt 2016	53*	420*
Toyota	Prius 2016	22*	600**
BMW	I3 Rex 2016	72*	150
	I8	15*	330*
	330e	14*	350*
Porsche	918 Spyder	12*	420*
Hyundai	Sonata 2016	27*	600*
Ford	Fusion 2017	22*	610*
Audi	A3 e-tron ultra	17*	430*

\* - EPA estimate

\*\* - Toyota estimate

As described in **table 2** the electrical range of HEVs is usually much lower than that of an EV. However, the total range of a HEV is far superior to the, best-in-class 270 miles total range of all EVs. With the current immature and expensive EV battery technology the HEV struggles to provide sufficient energy (from two engines) to meet most range and torque standards set by CVs (Williamson, 2013) Furthermore, HEVs usually incorporate charging technologies that are used to recharge the electric batteries while driving and braking (Williamson, 2013). HEVs can be fueled at regular gas stations and charged while driving or by directly charging it via a plug-in charger (Plug-in Hybrid EV: PHEV).

### Hydrogen Powered Fuel Cell Electric Vehicle

Another gradually emerging emission-free alternative is vehicles utilizing hydrogen or fuel cell technology that are often called “hydrogen cars” or Fuel Cell Electric Vehicles (FCEV). FCEVs are also an EV, albeit it with fuel cells to create the electricity, which propels an electric engine and charges an electric battery (Williamson, 2013). This technology requires compressed hydrogen stored in pressurized tanks, instead of stored electricity, and delivers electrical energy by creating a chemical reaction between hydrogen and oxygen (from the air) (Williamson, 2009; Office of Energy Efficiency & Renewable Energy, assessed 2016). The technology, or devices, which convert this chemical reaction into electricity is called fuel cells (Williamson, 2009).

Hydrogen vehicles emit only water (Hydrogen + Oxygen = H<sub>2</sub>O) and are therefore an environmental friendly and zero carbon-emission alternative to today’s CVs (Kriston et al.,

2010; Thomas, 2015; Toyota, 2016). There are only a few FCEVs on the market today and currently the 2016 Toyota Mirai is the most recent and prominent vehicle on the market. The Mirai has a price tag of \$58,000, which is severely higher than ICE-vehicles in its class. The range is EPA estimated to be 312 miles, which is further than the maximum distance of any production EV (see **table 2**). The Toyota Mirai will also refuel within three minutes compared to almost half an hour for the fastest EV chargers (Toyota, 2016).

As described in chapter 14 of “*Sustainable Transportation Options for the 21<sup>st</sup> Century and Beyond*” (Thomas, 2015). Several current and former leaders of dominant automobiles companies describe FCEVs as the future of the environmental friendly car and that the technology eventually will be able to overtake the ICE vehicles in the future. Further comments made by Toyota V.C. Takeshi Uchiyamada on FCEVs, suggests that Toyota believe that hydrogen cars hold “*far more promise*” than EVs, because of the EVs “*shortcomings*”. As of today, FCEV technology is perhaps the most environmental friendly option and can reduce GHG emissions, local air pollution and the consumption of fossil fuels such as petroleum and natural gas (Thomas, 2015).

The major challenges to FCEVs adoption identified by the US Department of Energy are 1) *Vehicle cost*, 2) *Hydrogen infrastructure*, and 3) *Fuel cell durability and reliability*. The cost of a FCEV is higher e than both CVs and EVs, as with the almost \$60,000 price-tag on the 2016 Toyota Mirai (US Department of Energy). Annual fuel costs, however, are cheaper than fossil-fuel vehicles and EPA (US Environmental Protection Agency) estimates the annual fuel costs to be \$1,250 for a Toyota Mirai (Fueleconomy.org, 2016). Like electric charging infrastructure, the hydrogen refueling infrastructure is in most places poor and proves a major challenge to the adoption rate of FCEVs.

### **Connected Car**

Today most vehicles are independent and rely mostly on the abilities of a human driver. Both the vehicle and the driver are unconnected from their surroundings, so the driver can only make decisions based on training, experience, abilities and general observations of the surroundings (Jonas, A. 2015). Radio, GPS systems and smartphone applications and internet connection can contribute to give some information about recent incidents, navigation, congested routes, and more. However, by connecting the vehicle directly to the internet, the vehicle is no longer unconnected and software can enable cars to communicate with other vehicles, infrastructure, vehicle manufacturers, and third-party service providers (Kessler &

Stephan, 2013; Abdelkafi, Makhotin & Posselt, 2013; Jonas, 2015; KPMG, 2015; ACEA, 2016).

Internet technology allows cars to communicate and seamlessly share information with each other and with other traffic control systems, in order to give the driver live updates about car congestion, incidents, road conditions ahead, available parking space, and approaching vehicles (KPMG, 2015; ACEA, 2016; CAR & MDOT, 2016). Moreover, this technology could result in increased road safety, resource efficient transportation, and create new markets for which new entrants can impact the automotive industry (KPMG, 2015; ACEA, 2016). This technology will also be quintessential to autonomous driving technology.

*“Time is of the essence. The potential size of the profit opportunity and the speed of user development have already attracted novel competitors like Google that try to disintermediate the critical man-machine interface in a car”*

- McKinsey & Company, “Mobility of the Future”, 2012

Connected vehicles will enable integrated communication and media systems that users can use during a trip or while driving. The integration of communication and media systems creates an additional opportunity for companies to capitalize on user’s time while in a vehicle (McKinsey & Company, 2012; KPMG, 2015). The value of capturing the attention of car passengers is estimated by McKinsey to be EUR 5 billion per minute for all worldwide car passengers combined (McKinsey & Company, 2012). Although many possible opportunities come with connected vehicle technology, there are still challenges to overcome in order to fulfill the potential of connected cars.

### **Autonomous (Self-driving) Technology**

*“An autonomous – or self-driving- car is one that can accelerate, brake and steer itself”*

- Erik Coelingh, Volvo, 2016

According to KPMG (2015) as much as 90% of traffic related accidents each year is caused by human errors. An autonomous vehicle (AV) is a car that is able to perform all functions of an ordinary vehicle including its driver’s capabilities, without any supervision (IHS Automotive, 2014; Anderson et al., 2016). AVs disconnect the human driver from being in control of the vehicles, as self-driving technologies enables the vehicle to drive by itself. The National Highway Transportation Safety Administration (2013) has defined four levels of AV driving systems (see **table 3**). These levels range from no autonomous features (level 0) to

fully autonomous driving (level 4). Level 1 and 2 includes basic AV features which many manufacturers have already implemented in their vehicles. Level 3 define full autonomous driving. Level 3 still requires the vehicle to be under the supervision of a driver, in case of occasional system issues or uncertainty (Ni & Leung, 2014).

Currently, some manufacturers like General Motors, Volkswagen, Tesla, Audi, BMW, Lexus, Mercedes and Volvo are launching various degrees of semi-autonomous features to their vehicles (level 1 – 3) (KPMG, 2015). Semi-autonomous technology allows the vehicle to steer, accelerate, brake, park, change lanes, observe its surroundings and be summoned from a parking spot/garage (Tesla Motors, 2015; Greenblatt and Shaheen, 2015; BCG, 2015; Volvo, 2016). However, like an autopilot on airplanes, the vehicle’s autopilot mode cannot be used without the drivers’ supervision, and can only be enabled in specific areas (e.g. highways). With semi-autonomous technology the driver is still held liable for the vehicle in the case of an accident. The liability of future AVs will be held by the manufacturer (Ni & Leung, 2014; Greenblatt and Shaheen, 2015; Bonnefonn et al., 2015; Anderson et al., 2016).

The technology for level 4 AVs is not completely ready yet, but several industry experts like Tesla CEO Elon Musk, the Norwegian minister of transportation Ketil Solvik-Olsen, IHS Automotive, analysts at Morgan Stanley, and industry insiders interviewed by McKinsey Consulting state that the technology for fully AV is being developed and that it will be ready to use within a few years (Greenblatt & Shaheen, 2015). Greenblatt & Shaheen (2015) also argue that all manufacturers have plans to introduce varying degrees of AV by 2017. However, regulations and legislation will probably postpone the launch of AVs to around 2020-2025 (Bertoncello & Wee, 2015; Morgan Stanley, 2015; Regjeringen, 2015; Fortune, 2015; Anderson, 2016; ACEA, 2016). KPMG’s *Global Automotive Executive Survey* (2015) found that fully self-driving cars are expected to be ready within 20 years.

Insurance companies will most likely experience a big decline in sales to individuals in the case of a transition to AVs, if the liability will be transferred to the manufacturers (Volvo Group, 2015; Greenblatt & Shaheen, 2015; Bonnefonn, et al., 2015; Anderson, et al., 2016; Ni & Leung). There is a chance that insurance companies will change their customer segment from providing individual insurance, to provide coverage for entire car fleets by insuring the car manufactures, or carsharing companies.

**Table 3: Vehicle Automation Level**

Automation level	Description
Level 0	No automation
Level 1	Autonomy of one primary control function, e.g., adaptive cruise control, self-parking, lane-keep assist, or autonomous braking
Level 2	Autonomy of two or more primary control functions “designed to work in unison to relieve the driver of control of those functions”
Level 3	Limited self-driving; driver may “cede full control of all safety-critical functions under certain traffic or environmental conditions,” but it is “expected to be available for occasional control” with adequate warning
Level 4	Full self-driving; driver “is not expected to be available for control at any time during the trip” (includes unoccupied vehicles)

(Source: National Highway Traffic Safety Administration, 2013)

**Table 4: Effects of Autonomous Vehicles**

Environmental	Social	Economic
Reduced fuel consumption (more efficient driving)*****	Less space required for parking  (Estimated 5,7 billion square feet in the US)	Huge productivity gains due to decreased time spent in traffic*/*****
Reduced GHG emissions (by 90%*****)	Improved mobility for elders and disabled*****	New business opportunities for the auto, telecom and media industry
Reduces Co2 emissions (see the above)	Safer Traffic: Reducing the number of traffic accidents, caused by human errors, and can monitor and guide human drivers***/*	Economic savings due to a reduction in accidents**/*
Reduces congestion due to more efficient use of road network (assuming connected technology)****	Can free time for users to spend on other activities	Potential digital-media revenue from internet usage within the car
	Increased efficiency saves time spent in traffic****	

(Source: ACEA, 2016; ACEA Press, 2016; Bertonecello & Wee, 2015; Morgan Stanley, 2015; Greenblatt & Saxena, 2015)

\* Estimated to be \$507 billion annually in the US alone (Morgen Stanley, 2015)

\*\* Annual cost of roadway crashes in the US economy \$212 billion in 2012 (Bertonecello & Wee, 2015).

\*\*\* Ni & Leung. “*Safety and Liability of AV Technology*”. MIT Computer Science and Artificial Intelligence Laboratory, 2014

\*\*\*\* Anderson, et al., 2016; Brown, et al., 2014; Morrow, et al., 2014

\*\*\*\*\* Greenblatt & Saxena, 2015 (Compared with today’s CV, by utilizing small, or compact, AVs in combination with sustainable energy production)

### 3.0 BUSINESS MODELS

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*“A business model is all about the question  
- how are you planning on making money?”*

- Michael Lewis, 1999

#### 3.1 THEORETICAL FOUNDATION

In chapter 3.1 we present relevant BM theories, and further explaining the importance of interaction between company, BM and technology/product. In addition, this chapter provides arguments that emphasize the importance of BM innovation in the context of technological shifts. The theories presented provide further arguments that explain how BM innovation should be conducted in the automotive industry, as they need to do better by doing different.

Moreover, we present arguments that emphasize the need for BM innovation as the current automotive BM is no longer viable. There will also be emphasis that the adoption of new technology requires the automotive industry to change their BMs. The theories presented in this chapter argue that a BM can maintain its competitiveness for certain number of years, (or in instances like the automotive industry - a century), however, it will *run out of gas* and be outperformed by new and innovative BMs.

The theoretical foundation of this thesis is based on the theories that explains how path-dependency, the inability to change, the relation of BM innovation and new technology adoption, and the importance of correlation between the BM and the adopted technology.

First, we present *disruptive technology theories about success factors and innovation dilemmas* by Clayton Christensen (1997). Next, we present arguments by (Margretta, 2002; Kaplan, 2012; Abdelkafi, Makhotin & Posselt, 2013) that states that the adoption of a new technology, or system, requires an equivalent shift in BM. Third, we present BM theories which argue that the adoption of sustainable technology is difficult with the existing production methods, company structure, and customer preferences, and that radical BM innovation is needed (Chesbrough & Rosenbloom, 2002; Johnson & Suskewicz, 2009; Kley et al., 2011 and Wells, 2013). Finally, we present theories by Johnson (2010), in order to further explain why companies need to change their BM to serve new markets, and present Johnson's (2010) *BM analogies* as these will be important in BM generation and analysis in chapter four.



Traditionally, a BM was more an accident than a planned model and was traditionally considered diffuse (Margretta, 2002; Wells, 2013). A model is a representation of the reality and is only as good as the assumptions that go into it (Margretta, 2002). There are many different thoughts and theories on what a BM should contain, and different BM theories are constantly changing over time. The early BMs were market driven, primarily focusing on surviving in the market by using competitive strategies rather than analyzing their value proposition, value creation etc. (Porter, 1980 and 1985). Chesbrough & Rosenbloom (2002) and Chesbrough (2010) defines a BM as the interaction of allocation decisions seeking competitive advantages, a value architecture, a profit model and a value proposition.

There is no consensus in literature about which individual elements a BM should contain, however most BMs can be classified by means of competitive advantages, resource allocation, value architecture, the customer value proposition and the profit value (Chesbrough & Rosenbloom, 2002; Chesbrough, 2010; Teece, 2010; Zott et al., 2011; Proff & Fojcik, 2014).

### **Disruptive Technologies**

Companies tend to stick to the same, well-known BM even in bad times, forcing it to become more effective by “cycling” faster and making minor adjustments to the existing model (Kaplan, 2012). Most leading companies have been shown to stick to their traditional BM, even if results are not returning to former heights and their success is challenged by disruptive technologies and products. Incumbent companies unable to innovate are eventually exceeded by companies with a new BM and products, and thus forced to lose their market share and relevance (Christensen, 1997; Chesbrough & Rosenbloom, 2002).

Path-dependency (existing organizational- and cost-structure, competence, customer base, financial incentives, goals and market position) limits automotive incumbents’ ability to rethink their BM in order to create a new, more efficient BM that allows for the adoption of sustainable technologies and less pressure on growth (Christensen, 1997; Chesbrough & Rosenbloom, 2002; Kaplan, 2012). In other words; in order for companies to identify new ways (paths) to profits when the current BM is “running out of gas”, managers need to stop “pedaling”, take a break and rethink the entire BM and find a better and more sustainable path to make money (Kaplan, 2012). In contrast, emerging, disruptive entrants often have a leaner and more efficient cost and organizational structure (Christensen, 1997). This enables them to

innovate and develop both their technology and BM faster and cheaper than the established competition (Christensen, 1997).

Today we see Google, Tesla, and Uber are currently working on AVs, and there are rumors in the media about an Apple self-driving vehicle (Greenblatt & Shaheen, 2015; Automotive News Europe, 2016). Importantly, Google and Apple's organizational structure reflects their innovative IT focused BM, which can potentially enable them to enter the automotive industry without the cost structure and path-dependency of the established car manufacturers.

A known phenomenon, in BM management, is that great companies are especially exposed to failure when faced with disruptive market changes. Traditional companies struggle to identify changes as their structure limits their ability to change (Christensen, 1997). Moreover, existing and conservative firms are struggling to adapt to changes in the environment, as they are often following their customers' demands without rethinking the current technology or creating products that the customers are not yet demanding (Christensen, 1997).

The introduction of disruptive technologies is usually not met with innovation by incumbents, as disruptive technologies usually are not competitive in the beginning (Christensen, 1997). Disruptive technologies are usually cheaper, provide simpler features and worse performing than the prevalent technology. However, as the disruptive technology improves and provides increased customer value for customers in existing or new markets, it captures market shares from the sustaining technology (Christensen, 1997; Gunther, 2011). **Figure 3** illustrates how a disruptive technology exceeds the existing technology over time.

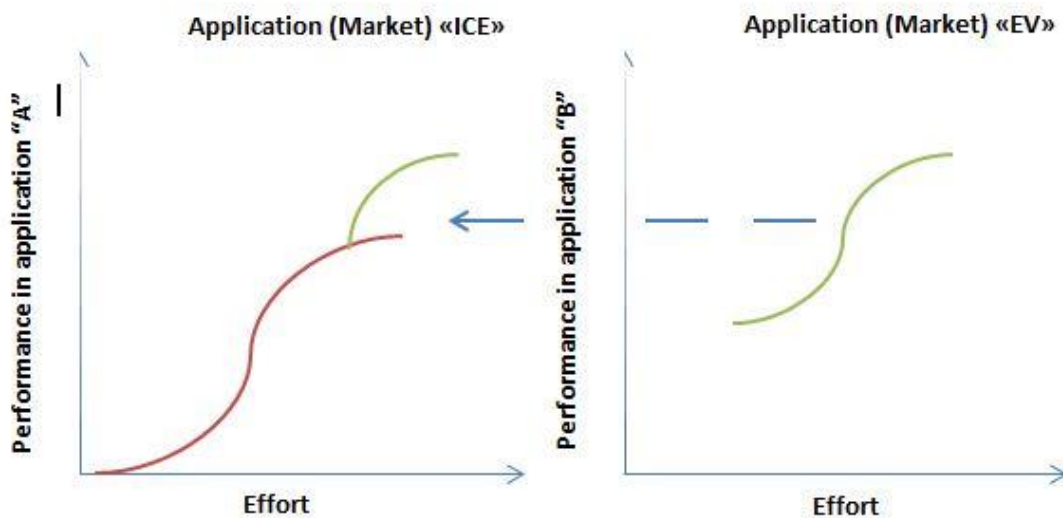
By managing a company's BM in order to act to disruptive change, managers can prevent their company's BM from being replaced by a more efficient, innovative, and sustainable BM (Christensen, 1997). Saul Kaplan (2012) refers to this phenomenon as, how to avoid being "Netflixed" by another company. What we see in today's automotive industry are companies, like BMW, SIXT, Daimler, Volkswagen and GM, who are establishing carsharing joint ventures and other subsidiaries in order to follow the development of disruptive BMs and technologies (Shaheen & Cohen, 2013; le Vine, et al., 2014; DriveNow, 2015; Greenblatt & Shaheen, 2015; Shaheen, et al., 2015; Shaheen, et al., 2015; Volkswagen, 2016). The parent companies of such carsharing services might be able to profit from this investment in the future, as the disruptive technology and carsharing markets eventually grow. In some instances these subsidiaries will capture market shares from the existing company

(cannibalization) and can run their predecessor out of business. By being cannibalized, the parent organization can adapt to the new market and restructure (Christensen, 1997).

Christensen’s theories on disruptive technologies and BM management will be used as a theory and tool to identify opportunities in emerging automotive technology and BMs. Further, disruptive technology theories provide arguments towards the future adoption of emerging disruptive power train technologies.

In this exploration, we assume that by continuously trying to improve on the existing BM, the automotive industry will risk losing their market to new entrants, with disruptive technology and BMs. Today, the current BM is profitable and no emerging BMs or technologies are strong enough to surpass the existing products. However, as technological breakthroughs improve new models and products, today’s disruptive technologies, BMs and services might catch up with the current model in the future. By then, it will be too late for the existing players to change (Christensen, 1997; Gunther, 2011). Based on the theories of Christensen (1997), it can be argued that today’s automakers need to rethink their BM and invest in disruptive technologies, in order to be the automaker of tomorrow.

**Figure 3: Disruptive Technology S-Curve**



(Source: Christensen, 1997)

In **figure 3** above, Christensen (1997) illustrates the product shift due to an emerging disruptive technology. If we were to use the automotive industry as an example, the ICE would represent the red line and the green line would represent the EV/FCEV. As time passes,

the growth rate of performance and benefit improvements of the existing technology (ICE) will decline and the new disruptive product (EV/FCEV) will absorb the market as it becomes a better product. When the performance/benefit of technology 1 surpasses technology 2, is where we have a change of the dominant product (Christensen, 1997). As of today, ICEs have already started to lose their growth potential and the EV/FCEV is in the startup phase just as illustrated above. To put it into perspective, EVs are less than 0,001% (1,3million/more than 1,2billion) of the total global vehicle fleet today and the FCEV is even smaller. (Green Car Reports, 2014; Statista: number of EVs in use, 2016).

### **Business Model Innovation**

*“Technology innovations and business model innovations are strongly linked to each other. A business model denoted the way how companies can make money out of a technology. No matter how the technology is innovative and sophisticated, it will fail, if it is not possible for market players to make profits from it”*

- Abdelkafi, Makhotin & Posselt, 2013

This statement can be used to emphasize why the emerging technological innovations of the industry must be accompanied by BM innovation in order to allow for profit in the automotive industry, this is further supported by Chesbrough (2006).

Margretta (2002) argues that every organization, profitable or non-profitable, have a BM, but not all organizations have a good and clear strategy. If one wants to run a successful organization one needs to focus not only on the BM, but also on the strategy connected to the BM (Margretta, 2002). If a company is entering an already existing market or a totally new market the company still needs to prepare for its rivals, because in every market there will be competition for the customers. When entering the market one needs to ask oneself, *“how can we do better? Is it easy for competitors to duplicate ones strategy, do we offer a product/service that is superior compared to the competitors? What extra value do we offer customers that the rivals are not offering? Which segment should we focus on?”* (Margretta, 2002). Why should companies spend time and money on BM innovation? According to Abdelkafi, Makhotin & Posselt (2013) an inferior technology with a better BM will often trump a better technology commercialized through an inferior BM. Innovation involves the creation of a new product, service or process.

Furthermore, Kaplan (2012) and Gunther (2011) argue that if a company wants to stay relevant as technology and markets change, it must innovate and develop its BM. Kaplan (2012) further argues that this can be achieved by creating an internal BM innovation “factory”, where its members are responsible for focusing and paying attention to BM innovation decisions. This group or “factory” should contain members from different levels of an organization, external and internal experts in addition to people of different education, age and culture, that insures against path-dependency (Gunther, 2011).

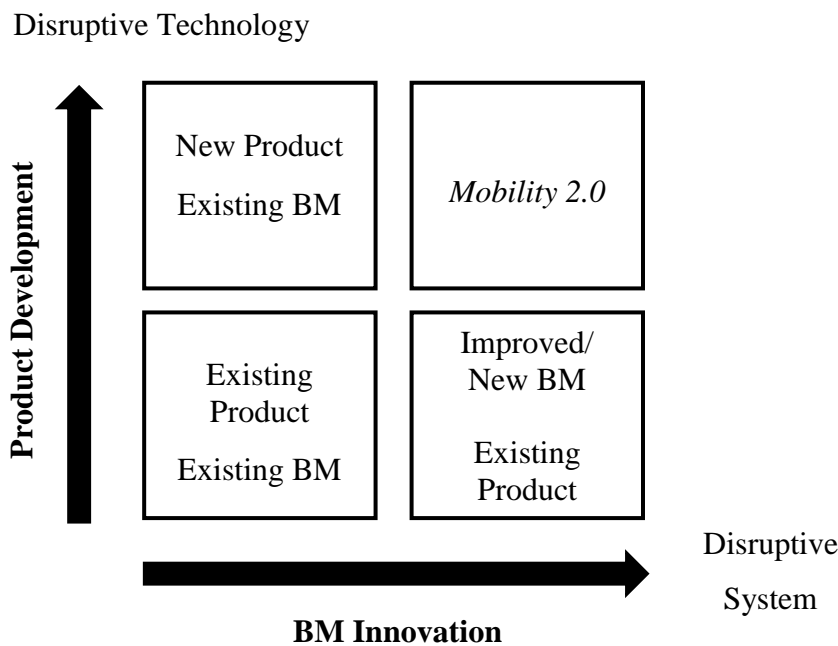
Kaplan (2012) argues for three factors that are important when designing/reinventing a BM: Companies need to decide how they want to *create*, *deliver* and *capture* value for their customers. By *creating* value Kaplan (2012) explains that the companies need to understand its customers by looking through the customers’ lens and work towards making the best possible value proposition. Further, companies *deliver* value by studying and implementing the capabilities that are most critical for its consumers. *Capturing* value is made by analyzing who actually pays for the product/service and how companies best can meet their needs and expectations.

*“Most organizations fail at BM innovation because they are so busy pedaling the bicycle of their current BM they leave no time, attention, or resources to design, prototype and test new ones”*

- Saul Kaplan, 2012

The automotive industry has only experienced minor changes over the previously 100 years, radical changes are expected over the next decade (Holweg, 2008; Wells, 2013; Abdelkafi, Makhotin & Posselt, 2013; PwC, 2014). New entrants, like Google, Uber and Tesla have already started to test full AVs, and there is pretty solid evidence of an existing Apple vehicle project (Project Titan) (Greenblatt & Shaheen, 2015). Could these firms have better luck implementing a new product, with new technologies, into the existing mobility market as their structure and current BMs are not limiting their venture into AV mobility services? These are companies with a different organizational structure and background than the existing car industry, and might have better conditions for innovation growth and implementation of a sustainable BM.

**Figure 4: Business Model Innovation**



As the automotive industry is experiencing a change towards the adoption of sustainable technologies in addition to the development of AV technology, automakers need to develop their BM to allow for successful sustainable technology implementation. Existing BMs are not adequate or suitable for a shift in product technology, from ICE-vehicles and unsustainable production, to EVs, FCEVs and AVs and sustainable production. Researchers argue that a radical shift towards sustainable technologies requires radical and comprehensive changes to the existing BM, production and social systems (Chesbrough & Rosenbloom, 2002; Johnson & Suskewicz, 2009; Kley et al., 2011; Wells, 2013). Similarly, Budde Christensen, et al., (2012) argues how the combination of a new, different, technology in a complex environment (automotive industry), requires the emergence and introduction of a new, innovative BM. Failing to analyze the whole comprehensive environment and system of sustainable technology will result in the development of inadequate and unviable BMs (Kley et al., 2011; Budde Christensen et al., 2012).

Kley et al., (2011) also argue that the adoption of EVs enables more comprehensive mobility solutions, which means companies have to consider moving away from product-based to service-based BMs. In other words, by trying to implement EVs (and other alternative power train technology) into a product-based BM, many companies will fail as EVs might not have transferable application and capabilities compared to existing ICE-vehicles. **Figure 4** above

illustrates the theories presented, and how both BM innovation and product development is needed in order to achieve a new, sustainable mobility BM, or *Mobility 2.0*.

### **BM Analogies**

The theories and analogies presented in Mark Johnson's (2010) "*Seizing the White Space: Business Model Innovation for Growth and Renewal*", are tools that can be used in the BM innovation process of this thesis. Johnson (2010) argues that companies, by adapting their BM and BM analogies to opportunities in new market, can alter the existing organizational structure to better serve new customers in a new way. By successfully altering the company's BM and enabling the company to target new customers, the company can increase their revenues and take advantage of changing new markets.

The theories presented by Johnson (2010) are highly applicable for this thesis, as the automotive industry require the development of a new, sustainable BM. The theories of Johnson (2010) can be used to move from the existing, unsustainable BM to a new, sustainable BM. Below follows a description of the most relevant analogies for this thesis.

#### *Bundle Elements Together*

This BM analogy involves offering a package of related goods and/or services together for added benefit for the customer. Traditional examples of this are fast food value meals and delivering iPod pre-installed and compatible with iTunes. In the automotive industry Tesla grants access to their worldwide network of super- and destination chargers free of charge (teslamotors.com, 2016).

#### *Freemium*

Providing a free service, or product, and then charge the customers for the extended version of the service, or product. From a carsharing BM point of view, this could mean giving away two weeks of free trial to get the customers "hooked" or charge the customers if they exceeded a free-driving-range included, of for example 5 miles per day.

#### *Do More to Address the Job*

Companies, who are working towards delivery of the complete product-package, are focusing on actual customer demand. BMW is a company that has extended their offerings from simply selling cars to selling mobility with their DriveNow concept. BMW are also offering additional service-offerings like leasing, insurance, customization packages, financial services and maintenance packages (Kessler & Stephan, 2013; BMW.com, 2016).

*Lease Instead Of Sell (Product-to-Service):*

Traditionally, auto manufacturers have been offering their consumers both the benefit of mobility, along with the product they are making, which is the car. This analogy is based on the idea that rather than simply selling the offered product, companies can provide the service that the product performs (sale-of-service) (Johnson, 2010). In the automotive industry this is basically what all carsharing companies are offering. Moreover, though many carsharing companies are operating differently, targeting different customers, charging their customers differently and supplying cars or simply the hard- and software that enables carsharing, the core idea behind their BM is designed around the (Product-to-service) *Lease instead of sell* analogue.

*Multi-Level Marketing*

Selling products directly to customers without the use of a third party dealership will save companies a lot of expense. Tesla has vertically-integrated dealerships so that customers can see, buy and test-drive their vehicles. Tesla also put effort into selling cars directly to customers online. In USA there is a legislative battle between Tesla Motors and the auto dealer lobbyists, who do not want to lose their share of the new car sale (Green Car Report, 2015).

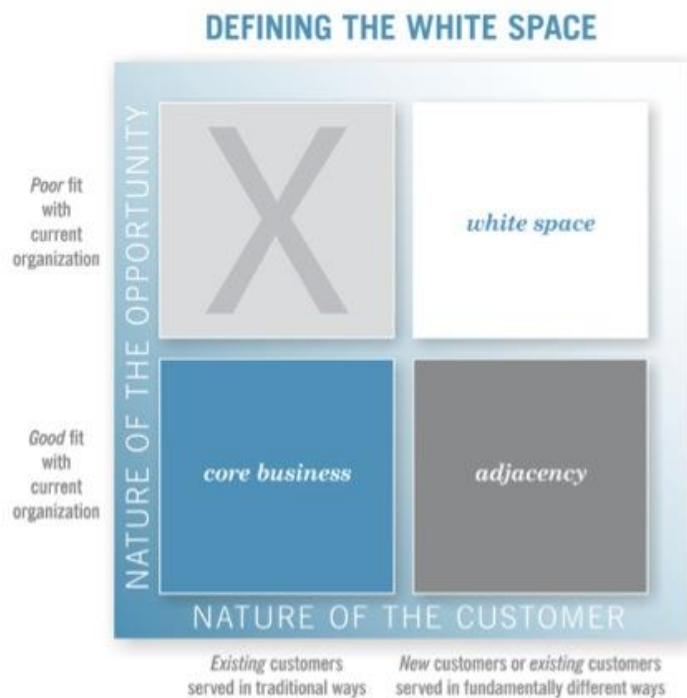
*Subscription*

A subscription based BM means that a company charges a subscription fee for their customers to gain access to a service (Johnson, 2010). In the automotive industry this has been adopted by carsharing communities and companies who are providing access and short-term-usage to cars. Examples of carsharing services who have adopted this approach is Autolib' and the DriveNow. Both services charge a fee, either on a per-month basis or per-use, which allows the customers access to a variety of available vehicles with all other auto relevant costs are included.

We have used Johnsons (2010) book to help define the “white space” in our mobility BM and **figure 5** can be related to our **figure 8** *The transition from mobility 1.0 to 2.0*.



**Figure 5: The White Space Matrix**



(Source: Johnson, 2010)

### **Business Model Generation**

Margretta (2002) points out that designing a BM is so much more than just making a model, it is about telling a two-part story. Firstly, one should decide what kind of product/service one want to offer/improve (how to design, manufacture and produce). The second part is about selling: How to sell? What is the best way to sell? (Which segment does a company want to target? How to distribute the product? Should one use a distribution center or a warehouse? What is the best way to deliver the service to the customers?)(Margretta, 2002).

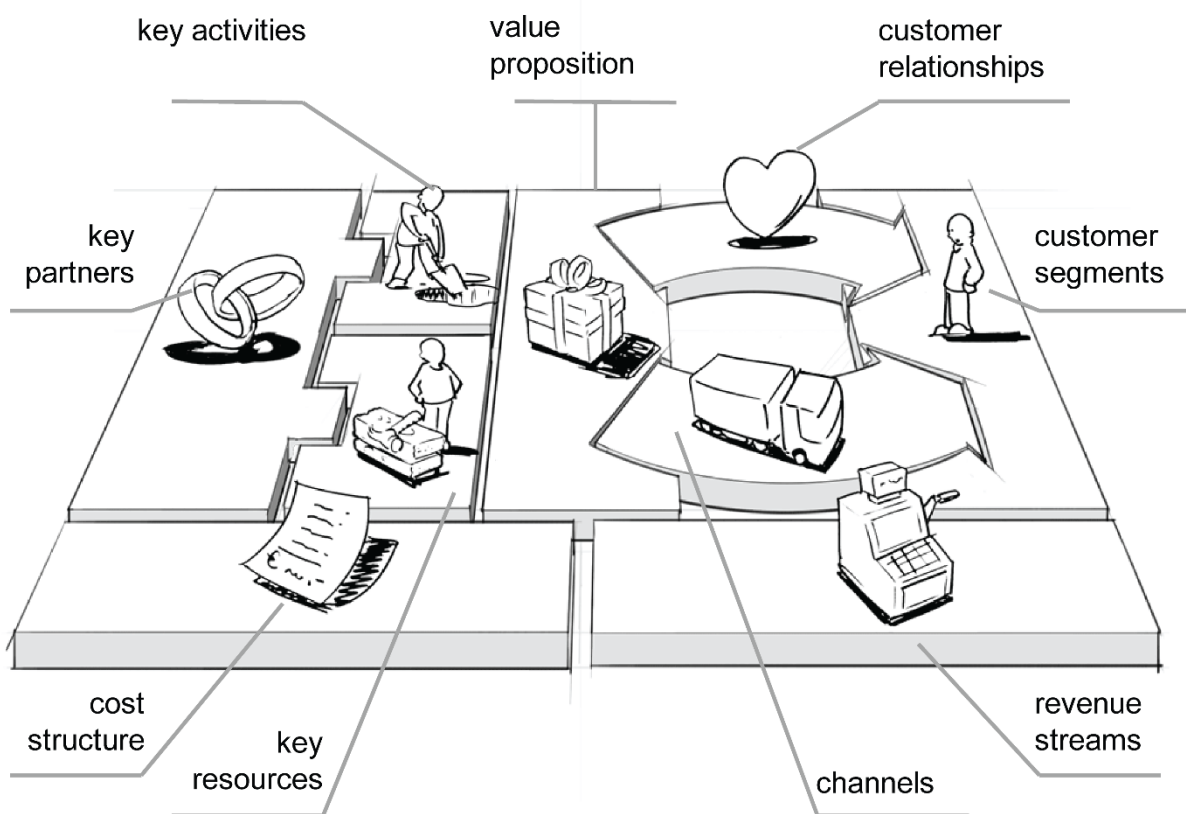
Christensen (1997) argues that successful companies operate in accordance with four elements. These elements are; *a customer value proposition* (how to perform the job better than our competitors?) *A profit formula* (how do we deliver the value proposition?) *Key processes* (essential processes for accomplishing the value proposition) and *key resources* (who/what can we not afford to lose?) Moreover, Osterwalder et al., (2010) present extensional theories on what Margretta (2002) refers to as the BMs building blocks. Whereas Margretta (2002) operates with two major elements (*what to offer?* and *how to sell it?*),

Osterwalder et al., (2010) introduce nine elements in their BM Canvas (see **figure 6**). The BM canvas can be used a strategic tool for studying and analyzing BMs. In Osterwalder’s (2010) own words;

*“The Business Model Canvas is a shared language for describing, visualizing, assessing, and changing BMs”*

We have used Osterwalder et al. (2010) comprehensive template (see **figure 7**) in chapter four, when conducting our BM analysis for both the existing and the new sustainable BM for the automotive industry (this is further visualized in **figure 13** and **14**).

**Figure 6: The Nine Building Blocks in the Business Model Canvas**



(Source: Osterwalder et al., 2010)

To better understand the content of the Business Model Canvas we have made a description for each of the different building blocks.

The first block in the BM is the *customer segment*. Here one must decide which customer or organizations one would like to serve. Some of the different segments are, mass market, niche market, segmented, diversified, multi-sided platform.

The second block is the *value proposition*. This block explains how the firm is planning on creating value for its customer segment. Some of the different strategies are customization, performance, brand, newness, price, cost reduction, design, risk reduction, accessibility, “getting the job done”, and convenience.

*Channels* are the third building block and in this part one chooses which channels one will use to reach the customer segment with the value proposition chosen in block two. When choosing a channel the question, “through which channels does our customer segment want to be reached?” must be answered. According to Osterwalder et al. (2010) channels have five different phases; awareness, evaluation, purchase, delivery, after sale.

*Customer relationship*: block four describes what kind of relationship a firm wants to have with its customers. Some of the relationships are personal assistance, dedicated personal assistance, self-service, automated service, communities and co-creation.

Building block five is the *revenue stream* and represents the revenue generated from the different customer segments. The question asked here is “for what value are our customers really willing to pay?” Some of the ways to generate revenue streams are subscription fees, brokerage fees, advertising, asset sale, renting/leasing and licensing, and usage fees. The pricing mechanism (fixed menu pricing or a dynamic pricing) will have a big impact on the revenue stream.

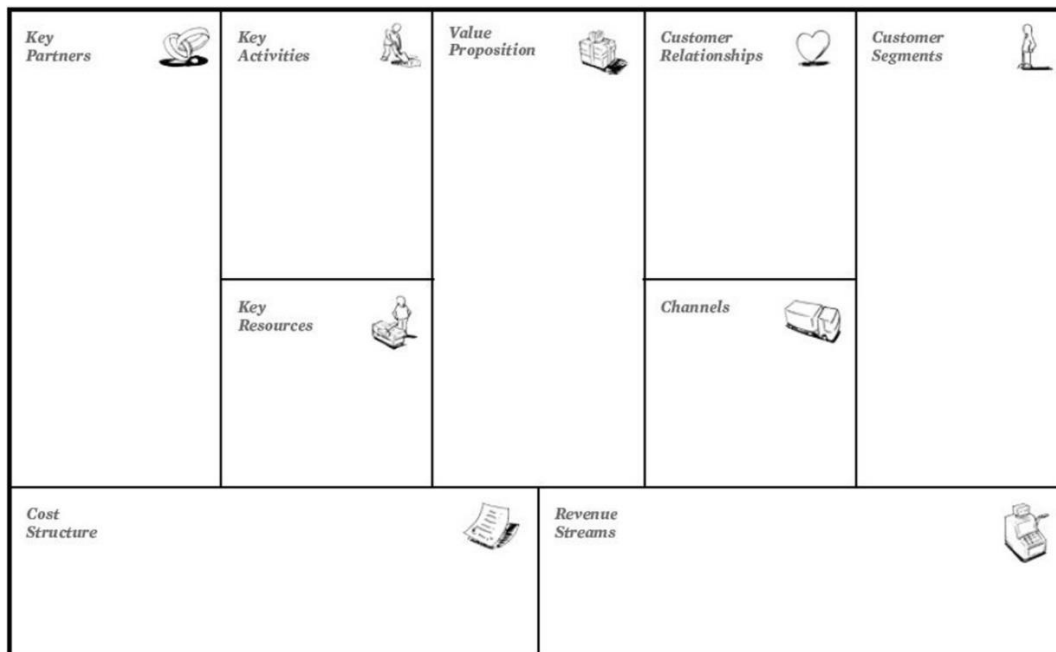
The *key resources* block describes the most important assets within the organization. Every organization needs resources to be able to create and offer a value proposition. Key resources can be financial, intellectual, human or physical resources.

A *key activity* describes the main things the firms need to do to make the BM work. Key activities can be categorized as follows: production, problem solving and platform/network.

Building block *key partnership* asks “which key resources are we acquiring from partners?” We distinguish between four different types of partnership: strategic alliances between non-competitors, cooperation (strategic partnership between competitors), joint ventures to develop new businesses, buyer/supplier relationship to assure reliable supplies. There are also different motivations for creating partnership: optimization and economy of scale, reduction of risk and uncertainty, acquisition of particular resources and activities.

The last building block is *cost structure* and describes how cost is incurred. The different strategies are cost driven, value driven, fixed cost, variable cost, economies of scale and economies of scope.

**Figure 7: Business Model Canvas Template**



(Source: Osterwalder et al., 2010)

## 4.0 MOBILITY 2.0

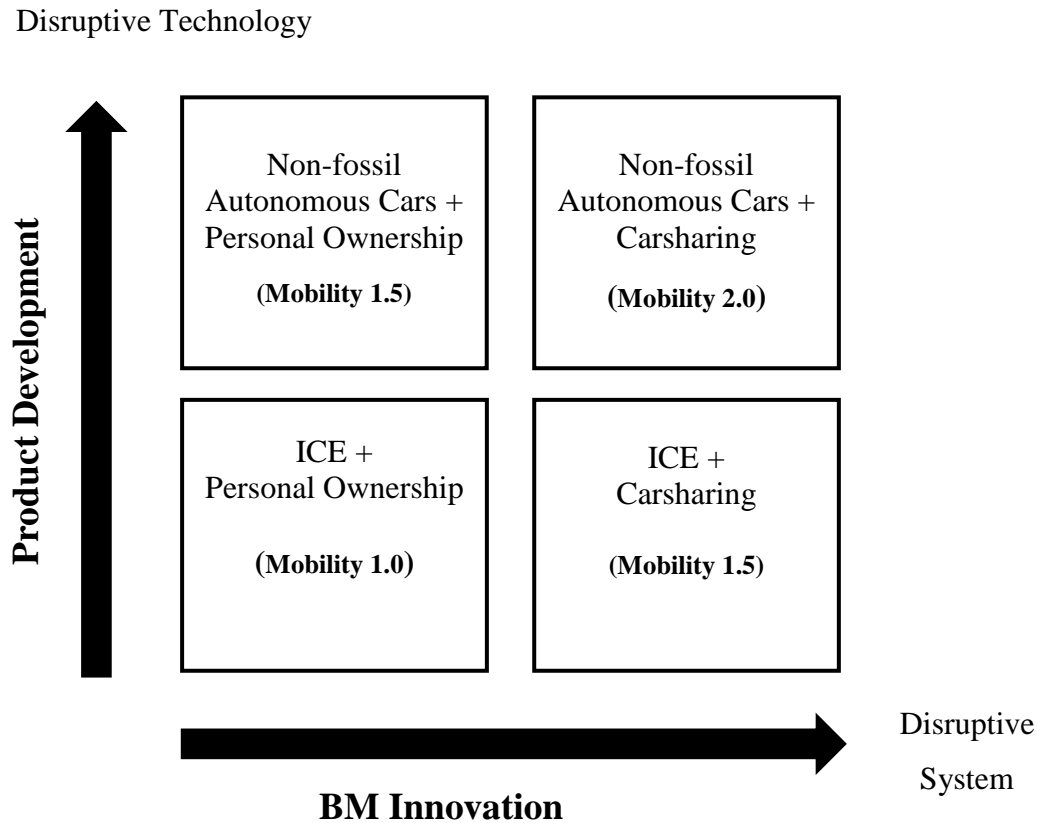
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Chapter two and three serve as the theoretical background and foundation of our research, in order to identify *future mobility business models*. The BM theories explored will be applied with our findings of current industry challenges and emerging technologies to identify new service-based mobility BMs. We have identified current and future challenges of the automotive industry, determining need for a new BM accompanied by product development in order to cope with the changes of tomorrow.

First, due to emerging markets, changing customer needs and demands and new connected technologies combined with BM innovation have created opportunities for service-based mobility services like carsharing to develop and be sustainable (Holweg, 2008; Kessler & Stephan, 2010). Service-based mobility enables companies to charge their customers for the service provided, rather than charging for a product. Carsharing services serve as an alternative to traditional ownership and in combination with BM innovation, it enables new opportunities in the mobility industry. In contrast to ownership, that is dependent on growth of new vehicle sales, sale-of-service mobility enable continuous, sustainable, revenue even in mature markets (Kessler & Stephan, 2010; Kessler & Stephan, 2013). We argue today's carsharing BMs provide a foundation for the service-based mobility BMs of the future. For this reason, they are used as the foundation of the analysis to identify new mobility BMs. Furthermore, we decided to use carsharing BMs as the foundation in our search for future sustainable BMs. This is because today's carsharing BMs present opportunities to overcome many of the challenges of the traditional automotive industry (Holweg, 2008; Kessler and Stephan, 2010).

In the second part of this chapter current carsharing BMs will be tested in relation to the challenges identified in this thesis and their interaction with emerging technologies of the automotive industry. Strengths and opportunities found in this analysis will serve as features to develop and describe potential and sustainable mobility BMs of the future. The new BMs identified in this thesis will derive from both BM innovation and product development, resulting in suggestions to future service-based models, or Mobility 2.0 BMs, for the automotive industry (see **figure 8**).

**Figure 8: The Transition from Mobility 1.0 to 2.0**



**4.1 DO CUSTOMERS KNOW WHAT THEY WANT?**

*“If I had asked my customers what they wanted,  
they would have answered a faster horse”*

- Henry Ford, 1928

It can be argued existing automotive BMs center on the perception that core customer need is to *own* a car so are continuously trying to produce and sell *more* and *better* cars than previously. The core customer need is essentially *mobility*. Emerging mobility BMs, like carsharing, are focusing on delivering cheap, convenient and efficient mobility to the customers. Whereas the existing industry BMs are focusing on delivering *better cars* to customers. As argued in chapter three, car manufacturers have to adjust their existing BM to utilize the potential of emerging technologies, adopt the sustainability views of carsharing BMs and thereby profit from consumers’ mobility needs. In addition to argued BM shift, other researchers argue that automakers need to shift their focus from product to service, by focusing on sale-of-service (product-to-service) mobility services (Slywotzky & Wise, 2003; Vargo & Lusch, 2004).

Carsharing services' sale-of-service BMs provide customers with vehicle access and charge customers per-mile driven. In order to provide further arguments of sustainability, we will in this chapter present research findings that provide evidence that carsharing reduce both car ownership and miles travelled, while increasing car access for its members.

#### **4.2 FROM SELLING CARS TO SELLING MOBILITY**

*“The principle of carsharing is simple: individuals gain the benefits of a private automobile without the responsibilities and car ownership costs”*

- Susan Shaheen & Adam Cohen, 2013

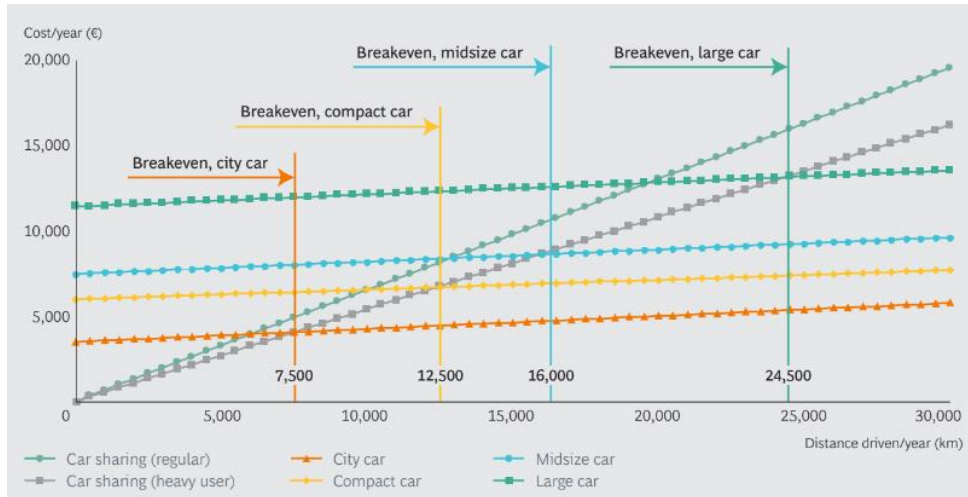
Today's established mass mobility model of individualized and flexible ownership is causing multiple challenges (Dennis & Urry, 2009; Kent & Dowling, 2013). The traditional model has been explored, it is evident it is failing to create sustaining high profits and continued market growth for the manufacturers in today's market situation (Nieuwenhuis & Wells, 2003; Holweg, 2008; Wells, 2013; Kessler & Stephan, 2013; PwC, 2014). Kessler & Stephan (2013) further argues that many automakers are developing strategies for diversification, and are transitioning into service-based services, and to become *“integrated mobility service providers”*. As we argue for the limited sustainability of selling cars in maturing markets, Gerybadze & Stephan (2003) supports this argument, by stating that long-term growth only can be achieved by adding, or expanding, a business' operations and activities.

Moreover, individual mobility is increasing congestion in urban areas due to accelerated urbanization and population growth, this consequently causes an increase of toxic emissions (Nieuwenhuis & Wells, 2003; Shaheen & Cohen, 2013; PwC, 2014 and 2015;). The emissions caused by traditional ICE cars can cause health problems in cities with high car density, as well as contributing to high CO<sub>2</sub>-emissions which are destructive to the earth's environment (Shaheen & Cohen, 2013; Rydén and Morin, 2005; WiMobil, 2015).

A car purchase requires a large up-front investment, followed by costs of insurance, parking, fuel, repair, and upgrade costs. The cost of owning a vehicle is increasing; the energy prices are continuously growing and taxation on high emission vehicles further increase the costs of private car ownership (Shaheen & Cohen, 2013). More factors like economic uncertainty, efforts to increase vehicle efficiency reduce GHG emissions, noise pollution, and shared-economy principles are all encouraging drivers to seek and find new alternatives to car ownership (Shaheen & Cohen, 2013).

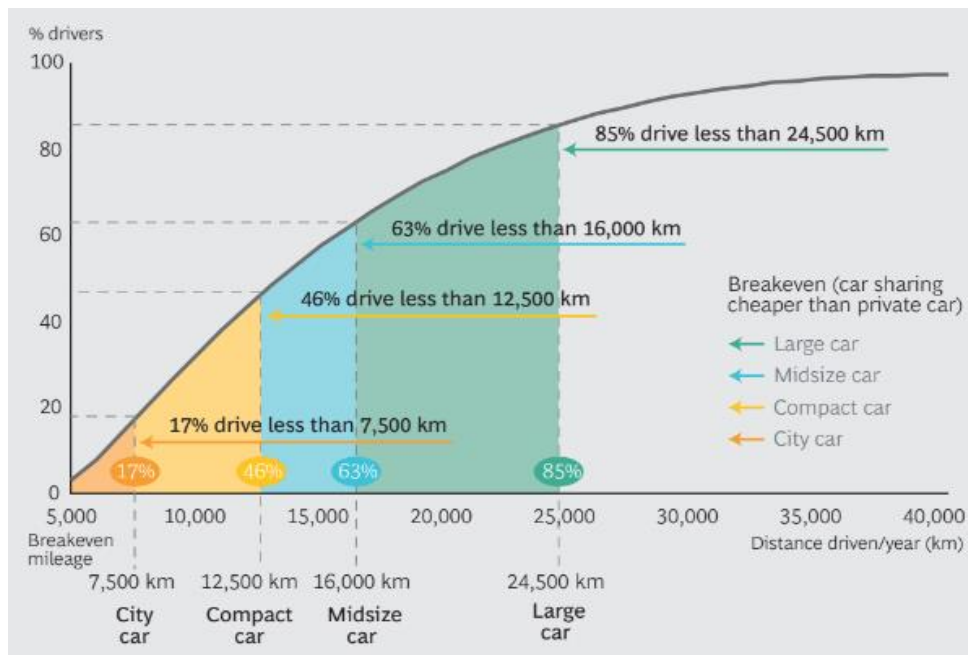
BCG has conducted a thorough comparison between carsharing services and car ownership costs. From **figure 9** we can see that a city driver who owns a car is break-even around 7,500 kilometers a year. For a medium-sized car one would have to drive around 12,500 km a year and 24,500 km for a large car. From **figure 10** we can see that 17% of the city drivers, 46% of the compact drivers and the majority of medium and large drivers would lower their total costs by switching to a carsharing services.

**Figure 9: Total Yearly Costs: Car Ownership vs Shared Cars**



(Sources: Allgemeiner Deutscher Automobil-Club car-sharing companies, BCG analysis, 2016)

**Figure 10: Total Driven Km: Car Ownership vs Shared Cars**



(Sources: Allgemeiner Deutscher Automobil-Club, DAT Report, BCG analysis, 2015)



*”E-mobility denotes a system of interacting actors, technologies, and infrastructures that aims to achieve sustainable transportation by means of electricity”*

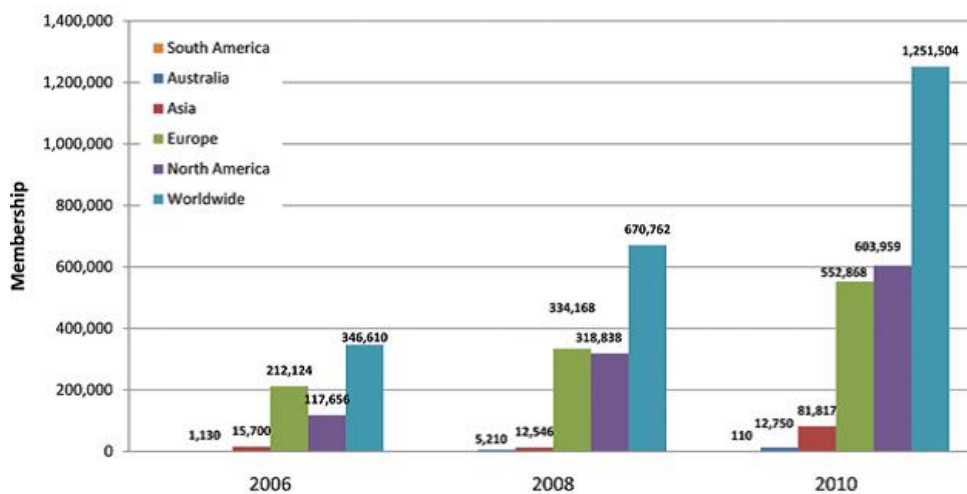
- Abdelkafi, Makhotin & Posselt, 2013:4

Recent developments in e-mobility have further led to a dramatic growth in carsharing usage, availability and visibility (Shaheen and Chan, 2015). E-mobility progress is further exemplified by technology, new industry entrants or products like keyless access, on-demand reservations, services with one-way abilities, and improvements in both electric infrastructure, EVs and HEVs.

### Carsharing Foundation

Carsharing is a system where members are access to a fleet of shared vehicles for short-term use, usually paying a charge for the usage only (Kent & Dowling, 2013; Shaheen & Cohen, 2013). The initial core idea behind carsharing is that being able to share the costs of initial car purchase, insurance, fuel and other fees among several users will create a cheaper car driving experience than personal ownership, which additionally reduce car ownership (Shaheen & Cohen, 2007; Carsharing Association, 2011; Shaheen & Cohen, 2013, Wappelhorst, et al., 2014). BCG (2016) has estimated the total global carsharing users to be more than 5,8 million, utilizing a fleet of 86,000 vehicles. Moreover, the number of carsharing users is growing rapidly each year as new carsharing operators are introduced into new and established carsharing markets, and as acceptance towards carsharing increases among the urban population.

**Figure 11: Carsharing Members Worldwide 2006-2010**



(Source: Shaheen & Cohen, 2013)

Since carsharing is usually designed for short term, short distance driving or sporadic use, members are often charged with a *per-mile* or *per-kilometer* or *per-day* fee (Carsharing Association, 2011). The carsharing charge includes the insurance, fuel, maintenance and often free or reduced cost parking (Carsharing Association, 2011; Shaheen & Cohen, 2013; le Vine, et al., 2014). Although long distance travel is not a traditional feature of carsharing, it is possible, and depends on the specific carsharing service BM (Carsharing Association, 2011). Another core idea of carsharing is to decrease the number of cars on the road, which again reduces car congestion in urban areas. This might further reduce today's emissions of toxic and GHG and dependence on fossil fuel (Rydén & Morin, 2005). It can therefore be argued that carsharing helps provide environmental and social benefits in areas where carsharing is common (Carsharing Association, 2011; Greenbratt & Shaheen, 2015).

Another purpose of carsharing is to encourage use of public transport by improving connections with public transportation, including bicycles (bike sharing) (Carsharing Association, 2011). Consumers gain access to a carsharing service by becoming a member of a certain program, which usually requires registration and a membership fee (Shaheen & Cohen, 2013). Vehicles are usually available for use 24/7, and vehicles can be located with a real-time tracking application at public parking lots, public transportation stations, the carsharing service's pick-up stations, universities, or other locations (Shaheen & Cohen, 2006; Carsharing Association, 2011; Shaheen & Cohen, 2013). Users get access to the vehicles with the use of a key, *smartcard*, or a smartphone application (ZipCar, 2016; Shaheen & Cohen, 2013; le Vine, et al., 2014; BMW DriveNow, 2016).

Furthermore, carsharing services is most common and currently most efficient in urban areas with a population of more than 500,000 in Europe and North-America, or 5,000,000 in Asia (BCG, 2016). Some programs are starting to grow into sub-urban residential areas and college campuses in North-America (Shaheen & Cohen, 2013). The largest carsharing markets today are Europe, North America (USA and Canada), Asia and Australia (Shaheen & Cohen, 2013).

Currently a wide variety of different carsharing BMs exists. The different BMs usually focus on different market segments. Shaheen and Cohen (2013) identify the most common BMs market segments as “*neighborhood residential, business, governmental and institutional fleets, and college and university*”.

## **Impact of Carsharing**

This subchapter provides a more thorough presentation of findings that argues for the sustainability of carsharing BMs. These arguments will provide impact features that will be analyzed and used as a foundation for the development of sustainable mobility.

Despite the carsharing subject receiving a great deal of attention, we found that most of the studies had been executed as a specified case study on environmental and ownership effects, and we had to spend some effort in analyzing the other general impacts of carsharing.

We present carsharing's impact on three main categories; overall impact on *environmental effects*, *social effects*, and *impact on the automotive industry*. Individual consumer benefits, such as financial impact, have been covered previously in the thesis and will thus not be covered

### **Environmental Effects**

It can be argued that the environmental impacts of carsharing will serve as important arguments in order for carsharing to grow as a mainstream alternative (complement) to conventional car ownership. We have previously identified adoption of environmental friendly transport alternatives and changing customer demands as important factors for auto-industry sustainability in the future. For carsharing to be a *better* and *sustainable* transportation alternative, it needs to contribute to positive environmental impacts.

It has been determined that increased introduction of EVs into carsharing fleets is a growing focus for many carsharing operators (e.g. DriveNow and Autolib') (Shaheen & Chan, 2015; Greenblatt & Shaheen, 2015; DriveNow, 2016). Unfortunately, many of the studies we used to analyze the effects of carsharing did not include the recent growth of EVs in carsharing fleets, and most had been studying the effects of CV carsharing fleets, or EV and FCEV carsharing fleets as separate limited projects (Rydén, 2005; Kriston, et al., 2010; Firnkorn & Müller, 2011; Baptista, et al., 2013; d'Arcier & Lecler, 2014). As EVs emits no GHG emissions (overall environmental effect is dependent on emissions from energy production), we further assume that increased EV fleets will further enhance the environmental effects of carsharing found in this chapter (Shaheen et al., 2015).

Although there is a lot of case-literature on the environmental effects of carsharing, many of the studies usually rely on surveys conducted by Martin & Shaheen (2011), Shaheen et al., (2015), Wappelhorst et al., (2014), Rydén & Morin (2005), WiMobil (2015) and Shaheen &

Cohen (2012). These surveys were found to be some of the most cited and, much of our arguments are based on data and research provided by these studies.

*Reduces GHG emissions and air pollution*

The most prominent and important impact of carsharing on the environment is its effectiveness in reducing transportation caused GHG emissions and air pollution (Rydén & Morin, 2005; Martin & Shaheen, 2011; Shaheen & Cohen, 2013; WiMobil, 2015). While studies have shown that carsharing actually increases GHG emissions from users from zero-vehicle households, because of increased vehicle access (Martin & Shaheen, 2011). Users from one- or more vehicle households were found to reduce their GHG emissions (Martin & Shaheen, 2011). As a result, the overall reduction in GHG emissions from the users who own, or owned, a personal vehicle were larger than the increased GHG emissions from zero-vehicle households, and the total effects of carsharing is reduced overall GHG emissions (*and air pollution*) (Rydén & Morin, 2005; Martin & Shaheen, 2011).

We have identified *reduced average miles/km travelled per year, the use of more fuel efficient vehicles and increased environmental awareness and increased use of alternative transportation* as the three main reasons to GHG emissions reduction.

Research has found carsharing to reduce the vehicle miles travelled (VMT) per year among users of up 20%-27% (Rydén & Morin, 2005; Martin & Shaheen, 2011; Shaheen & Cohen, 2013; Shaheen et al., 2015). Again the reduction in VMT is an overall result; where the users who previously did not have access to a vehicle increased their VMT per year, but where the reduction in VMT per year from users from one or more-households is larger than the initial increase (Martin & Shaheen, 2011). The reduction in VMT is usually a result of three factors: 1) several of the users from vehicle-households shed/sold a car after joining a carsharing program, 2) more efficient use of vehicle, as users have to plan their vehicle use, which results in fewer trips, and 3) carsharing users were found to increase their use of alternative transportation modes such as walking, public transport and cycling (Martin & Shaheen, 2011; Shaheen & Cohen, 2013).

New cars are becoming increasingly fuel efficient as manufacturers improve the current technology and work to meet governmental regulations. Studies show that carsharing fleets consists of newer cars than the average car fleet within countries, combined a regular use of small compact car with high fuel efficiency (Martin & Shaheen, 2011; Kent & Dowling, 2013; KPMG, 2015). Additionally, carsharing fleets consisting of EVs, in any ratio, have

been shown to further decrease the GHG emissions and air pollution of carsharing fleets (WiMobil, 2015). New, fuel efficient compact vehicles, EVs and HEVs in carsharing fleets, therefore reduce the overall GHG emissions compared to private ownership, assuming that carsharing services consists of users of both zero-vehicle households and vehicle-owners (Martin & Shaheen, 2011).

Furthermore, carsharing services were found to increase environmental awareness (Shaheen et al., 2015) and the use of alternative transportation among its users (Millard-Ball, et al., 2005; Martin & Shaheen, 2011; Shaheen & Cohen, 2013). Several carsharing programs like DriveNow and Flinkster provide software (e.g. Moovit) that enable cooperation and route information between the carsharing service and public transportation (Martin & Shaheen, 2011; DriveNow, 2016). Thus, the increased use of carsharing in combination with alternative transportation leads to a reduction in actual vehicles on the road, enhancing the positive impact of carsharing on GHG and air pollution (Martin & Shaheen, 2011; Nenseth, Julsrud & Hald, 2012; Shaheen & Cohen, 2013; Avis Budget Group, 2015;).

### **Social Effects**

#### *Car access for more people and households*

Carsharing provides access to a cheap and efficient mobility alternative for users who do not own a car (Rydén & Morin, 2005; Nenseth, Julsrud & Hald, 2012; Shaheen & Cohen, 2013). These users can include college students, low-income households, business users, or car-owner users who find carsharing more efficient than adopting another vehicle. Additionally, carsharing provides users with low-use demands (users with VMT demand) an alternative to traditional car ownership (Shaheen & Cohen, 2013). By targeting users who either do not own a car, cannot afford a car, or for whom it is inefficient to own a car, carsharing can deliver far more value to several market segments than traditional car ownership (BCG, 2016).

#### *Lower vehicle congestion in urban areas*

Average vehicle-use is estimated to be between 30 minutes to one hour a day, resulting in most vehicles being unused for more than 23 hours per day (Nenseth, Julsrud, and Hald, 2012; Morgan Stanley, 2015). By deploying carsharing fleets, a vehicle can be used by more than one household, which results in higher efficient vehicle use. By shared vehicle use and increased efficiency, results in a need of fewer vehicles all together.

**Table 5: Number of Privately Owned Vehicles Replaced by Carsharing**

<b>Numbers of privately owned vehicles replaced by carsharing</b>	<b>Region</b>
7-10	Australia
4-10	Europe (including Turkey and Russia)
9-13	North America (Canada and the US)

Source: (Shaheen & Cohen, 2013; Martin, Shaheen & Lidicker, 2010)

*Space savings*

Urban carsharing have been shown to reduce the space needed for parking, as a there are a reduced number of privately owned cars on the road in need of parking space (Nenseth, Julsrud & Hald, 2012; Shaheen and Cohen, 2013; WiMobil, 2015). Further benefits of reduced parking needs, are the economic and time savings of not having to pay for, search for and building parking facilities (Millard-Ball, et al., 2005; Nenseth, Julsrud & Hald, 2012).

**Impact on the Automotive Industry**

*“Indeed, the US Department of Energy recorded a drop in ownership of four million vehicles in 2009 – the first significant decline since it began recording in 1960 (Mittelstaedt, 2010).*

*This decline coincides with a growing prevalence of alternative modes such as traditional carsharing and the development of new models such as personal vehicle sharing (short-term access to privately-owned vehicles”*

- Shaheen, Mallery & Kingsley, 2012.

The most disruptive impact of carsharing will be its impact on the existing automotive industry. As current research on the impact of carsharing was not completely satisfactory, we proceed by presenting the effects of carsharing on the automotive industry by combining findings in research, market reports and press releases by auto and mobility industry stakeholders.

*Impact on sales*

Although studies have shown that many carsharing users have sold their car, or sold one of their cars, after joining a carsharing program (US Department of Transportation, 2001; Martin & Shaheen, 2010 cited in Shaheen & Cohen, 2013), further market research also show that carsharing will not reduce new-vehicle sales by more than 1% by 2021 (BCG, 2016). The global carsharing industry of 2015 was estimated to include 86,000 vehicles and 5,8 million users worldwide, generating EUR650 million in revenue (BCG, 2016). As of 2021, the

carsharing industry is estimated to grow into 228,000 vehicles and 35 million users, generating EUR 4,7 billion in revenue worldwide (BCG, 2016). However, these estimated numbers are microscopic in comparison to the hundreds of billion in revenue generated by the global automotive industry each year, which implies little near-future impact on the automotive industry (Statista, 2014).

When analyzing carsharing's impact on new car sales we found *three* main findings which impact car sales: 1) *Reduced car-ownership*, 2) *carsharing fleets*, and 3) *market segment demands*.

Reduced car-ownership and increased use of intermodal transportation will have a negative impact on car sales (BCG, 2016). BCG estimates near future growth of carsharing will result in loss in revenues of EUR 7,4 billion (BCG, 2016).

As carsharing gains traction, carsharing services will require a growing amount of new cars to provide available vehicles, sufficient range and industry leading security. Mobility services usually consist of a fleet of new, updated vehicles, which is due to security regulations and cost constraints. Carsharing operators will become a major customer of car manufacturers due to growing carsharing fleets, similar to rental car companies today (Shaheen & Cohen, 2013; Le Vine, Zolfghari & Polak, 2014; BCG, 2016). Thus, the growth of carsharing will replace potential revenue losses caused by declining personal ownership in mature markets (Shaheen & Cohen, 2013; BCG, 2016). Additionally, the increased focus of most one-way carsharing services to introduce EVs and HEVs to their carsharing fleets also creates an opportunity for EV and HEV manufacturers (Shaheen & Chan, 2015).

Furthermore, research from Germany on carsharing attitudes, suggested that 70% of young-adults believed that they would own their own car within ten years (McKinsey, 2012). The same study also found that 78% of today's young-adults believed that owning an expensive car would give greater status than any other luxury good (McKinsey, 2012). Studies further show that different market segments show contrasting openness to adopting carsharing services. As young adults are most likely to adopt carsharing practices, middle-aged and older consumers are still hesitant towards carsharing and will probably continue to buy new vehicles (Canzler & Knie, 2009; BCG, 2016). These two markets will further dampen carsharing's impact on overall vehicle sales, as these segments are the most important for new-car sales (Canzler & Knie, 2009). These findings, combined, might suggest that current service-based services will not cause any dramatic impacts on car sales in the near future.

*Impact on structure and strategy*

Global carsharing memberships are estimated to explode from 5,8 million users to 35 million worldwide users in 5 years (BCG, 2016). The estimated growth in revenue is estimated to follow the same path, and the current service-based mobility models do not look like they are going to disrupt the existing automotive industry. However, there are definitely long term opportunities for automakers and new entrants that take advantage of the potential of the mobility industry (PwC, 2012, Kessler & Stephan, 2013; Le Vine et al., 2014; KPMG, 2015; BCG, 2016).

Today, companies like GM, Daimler, BMW, Hertz, Volkswagen, SIXT, Budget, Kia, Peugeot, Toyota, Ford, and Avis Budget Group have all addressed the changes in the mobility industry by becoming involved in different carsharing operations (Kessler & Stephan, 2013; Shaheen & Cohen, 2013; DriveNow, 2015; Zipcar, 2016). Automotive news and automotive researchers are reporting that Google and Apple are outspending automakers on R&D investments, and that they are targeting service-based mobility opportunities in the near future (Jonas, 2015; Bloomberg Autonews, May 2016; FCA, 2016). It can be argued that OEMs within the automotive industry looks to have identified the disruptive forces of carsharing and mobility BMs and are already positioning themselves in order to gain near- and long term profits from *selling miles* (Kessler & Stephan, 2013). Some companies have entered the carsharing industry by obtaining established carsharing providers, like Avis Budget Group's acquisition of Zipcar. Others have entered the carsharing sector through strategic collaborations and joint ventures, in an attempt to diminish risks and create synergies (Christensen, 1997; Shaheen & Chan, 2015). Examples of joint venture carsharing collaborations are DriveNow, a JV between SIXT SE and BMW, car2go, a joint venture between Europacar and Daimler, and the partnership between Renault and Bolloré to develop and introduce EV to carsharing fleets (Renault Media, 2014; DriveNow, 2015; Shaheen & Chan, 2015). Further, rental companies seem to have organizational strengths that can complement their carsharing operations (rebalancing systems, insurance systems, modern fleet, sharing capabilities). However, the situation of rental companies investing in carsharing resembles Christensen's *cannibalism* theory, as rental companies are entering into the carsharing industry in order to ensure future survival, although the initial BM might lose all its customers to its new, competing entity (Christensen, 2001).

Le Vine, Zolfghari & Polak (2014) identified that automakers have both organizational strengths and weaknesses related to the potential entry of carsharing services:



**Table 6: Automakers' Organizational Strengths and Weaknesses of Carsharing**

<i>Strengths</i>	<i>Weaknesses</i>
Financial depth to invest and self-insure	Not traditional core competency and requires allocating resources to set up dedicated teams
Vertical integration between vehicle manufacturing and service provision allows telematics equipment to be efficiently designed and fitted into carsharing vehicles in the factory, rather than as after-market add-ons	Needs to invest in information-technology systems
Leverage existing organizational strengths (IT-systems, market research, brand recognition, optimal vehicle maintenance regimes)	Purchasing insurance in the insurance market, can be 3-4 times as expensive as self-insurance

(Source: Strengths and Weaknesses: Le Vine, et al., 2014)

Furthermore, by becoming a carsharing provider or collaborator with a carsharing service, car manufacturers can build brand recognition, through visible branding and vehicle access, and brand loyalty among young adults (Le Vine, et al., 2014). Le Vine, et al. (2014) argue that by serving young adults, and other market segments, with their vehicles, car manufacturers can build brand loyalty as carsharing users get increasingly accustomed to their vehicles. As previously described most carsharing users still desire to own a car in the future, and might opt for the vehicle that they are used to. However, further research is required on this topic.

*Autonomous Vehicle Positioning*

Most of the findings presented in this subchapter argue that carsharing simply will not have detrimental impacts to disruptively change the current automotive industry. However, it might provide a structural foundation for future disruptions. Many researchers and industry experts forecast that the introduction of fully automatic vehicles will be the technological tool that will cause mobility BMs, as carsharing, to create major disruption to the current automotive industry (Kessler & Stephan, 2013; Le Vine, et al., 2014; Shaheen & Chan, 2015; BCG, 2016). Organizations that act now might be able to develop the necessary knowledge and structural strengths to take advantage of the introduction of AVs. Collaborations between companies and independent companies able to take advantage of the disruptive changes to the industry might come from outside the industry. Especially as these companies might have better suited organizational traits for an autonomous carsharing BM.

### **Growth of Carsharing and Mobility Services**

*Accelerated urbanization* is presented as a factor that contributes to the growth of carsharing. If the estimated population growth, in already densely populated cities, estimated by UN-DESA (2012) is accompanied by an equivalent growth in cars, it will arguably have a dramatic effect on and potentially destroy the current transportation system and lead to extreme congestion in densely populated cities (Shaheen, Chan & Micheaux, 2015).

*Demographic shifts* will furthermore contribute to carsharing growth as young consumers, especially in western markets, are emerging as consumers with different demands patterns than traditional consumers (McKinsey, 2012; PWC, 2015; KPMG, 2015). However, contrary to previous beliefs the young generations are still striving for car ownership and they still have high mobility needs (McKinsey, 2012; KPMG, 2015). These consumers require media integration, access to efficient and individual mobility solutions in combination with supplemental sharing (ride- and bikesharing) and intermodal mobility services (McKinsey, 2012; Wappelhorst, et al., 2013; Shaheen & Cohen, 2013). Moreover, increased media coverage on the negative efficient effects of cars, GHG emissions and other toxic emissions, create awareness among younger consumers towards their mobility carbon footprint, which further increase the openness towards carsharing services (McKinsey, 2012; Cohen, Mallery & Kingsley, 2012). We further suggest that the changing consumer demands and needs create opportunities for companies that are able to connect and adapt their service and BM to the changing demands of customers (Abdelkafi, Makhotin & Posselt, 2013; PwC, 2015).

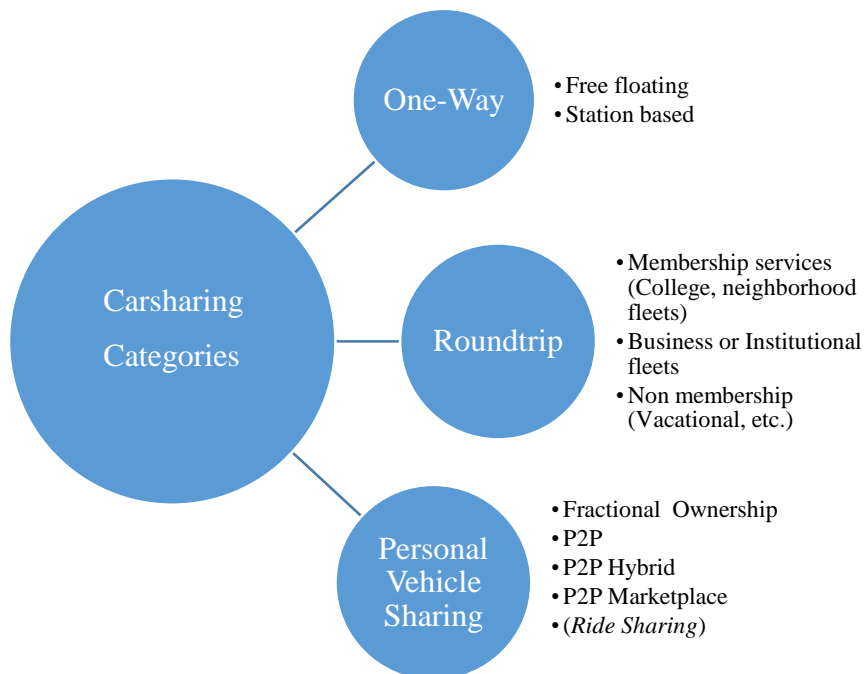
*Technological breakthroughs* arguably lead to increased improvements and technological advancements in alternative power trains, digitalization, automotive software and hardware, connectivity and smart phone technologies which are further contributing to the growth of carsharing (Shaheen & Cohen, 2012; McKinsey, 2012; Wappelhorst et al., 2014). This implies that breakthroughs in connectivity and technology enable carsharing services to appear and operate more efficiently. User-friendliness and new possibilities allowed by new technology suggests that many mobility consumers do not need to own a private car, and are more positive to use a carsharing services in combination with public transport, or as an alternative to their personal car (McKinsey, 2012; Wappelhorst et al., 2014).

The journey characteristics of most journeys performed with carsharing make smaller compact- and hatchback vehicles dominate models in carsharing vehicle fleets (Shaheen & Cohen, 2010). Other vehicles sizes like sedans, vans, pick-up trucks and small SUVs are also offered, especially in round-trip services (Shaheen & Cohen, 2013). Until the late-2000s,

gasoline and diesel engine cars were the dominant fuel and engine technology in most carsharing fleets in both Europe and North America (Shaheen & Cohen, 2013). However, around 2010 the industry saw an increased focus towards, and introduction of, EVs and HEVs in carsharing fleets (Shaheen & Cohen, 2013). The shift towards EV introduction was especially strong in one-way BMs in Europe, Asia and some North American areas and will continue to be one of the key emerging trends of the carsharing industry (Shaheen & Cohen, 2013; d’Arcier & Lecler, 2014; Shaheen & Chan, 2015).

### 4.3 CARSHARING BUSINESS MODELS

**Figure 12: Carsharing Categories**



In this section, there will be a focus on describing different carsharing BMs as we use them as foundation when identifying new futuristic BMs (*Mobility 2.0*). Today’s carsharing services are usually smartphones operated, which enable users to book a cheap ride to a certain destination, or connect with intermodal mobility services. The objective of chapter 4.3 is to present a thorough presentation of the different carsharing BMs used in today, and which we are going to use in our analysis of mobility opportunities in chapter 4.4.

The different carsharing practices will be categorized into *one-way* and *round-trip* carsharing practices, as presented in “*One Way carsharing’s evolution and operator perspectives from the*

*Americas*” by Shaheen, Chan & Micheaux (2015). In addition, we add *personal vehicle sharing* services as the last of three carsharing categories presented in this thesis. By our definition, *personal vehicle sharing* includes all carsharing services that involve sharing a privately owned, or member-owned, vehicle, compared to company/organizational owned vehicles.

### One-way Carsharing

*“From a user’s point of view, one-way carsharing systems are a better option for more trip purposes than round-trip services”*

- Jorge et, al., 2015, p. 12

**Table 7: Benefits & Strengths of One-way Carsharing**

<b>Benefits &amp; Strengths</b>	
<i>Strength</i>	<i>Explanation</i>
Flexible	No reservation needed, distance, duration, pick-up and drop-off location
Short journeys	Suitable for most short trips, durations, distances, locations, use
E-mobility: Smart phone application	Enabled through technological breakthroughs in e-mobility operated by a smartphone application
Urban areas	Most efficient in densely populated areas
Substitute for public transportation (Free-floating)	Many trips can be performed solely with the use of free-floating carsharing
Complement Public transportation (Station-based)	Intermodal transportation; connects users with other public transportation
Cheap	Cheaper than car-ownership for users with low mobility needs
All-included (usually)	Miles, fuel, insurance, parking, toll charge, tax, etc.
Efficient	The most efficient usage of a vehicle when system is fully booked










One-way carsharing is a carsharing service which is based on journeys to a certain destination, without the need to drive the vehicle back to its original pick-up location. One-way carsharing is characterized that the shared vehicle can be dropped off at a different location from where the vehicle was obtained (Shaheen, Chan & Micheaux, 2015). One-way carsharing enables great flexibility in pick-up location, end destination, mobile vehicle tracking technology, short journey distances, spontaneous booking, and features like pay-per minute (Shaheen, Chan & Micheaux, 2015). It is most popular and viable in dense city centers (Shaheen, Chan & Micheaux, 2015). The availability of public parking and the density of users, allows for a more efficient usage and relocation of the vehicles.

Flexible availability is one of the key characteristics of the one-way carsharing service. It has been found to be the fastest growing carsharing category in today's changing mobility industry. It is forecasted that one-way carsharing services will further evolve due to expansions, innovation and increased investments (Shaheen, Chan & Micheaux, 2015; DriveNow, 2015; Boston Consulting Group, 2016; Forbes, 2016; General Motors, 2016).

Benefitting from technological advancements and digitalization have made the operation of one-way carsharing services easier, enabling these services to expand intensely (Shaheen, Chan & Micheaux, 2015; Jorge et al., 2015). Public policies that enable private companies to reserve, access and pre-pay on-street parking are other influence which further enables the expansion of one-way carsharing (Shaheen & Cohen, 2007).

Free-floating

**Table 8: One-way Free-Floating Carsharing Business Model**

<p><b>Key Partners</b> </p> <p>Strategic Alliances (between non-competitors e.g. shopping centers, airlines, IT-companies with large user databases)</p> <p>Joint Venture (with competitors e.g. car rental companies, automakers, public transportation)</p> <p>Collaboration (with city/municipal institutions and governments, businesses located in area of operation)</p>	<p><b>Key Activities</b> </p> <p>Managing and developing carsharing application and software</p> <p>Customer care and feedback</p> <p>Refueling/Recharging</p> <p>Engage with partners</p>	<p><b>Value Proposition</b> </p> <p>Internet-enabled, short time, flexible mobility (vehicle by the minute)</p> <p>All included (no extra charges, no hassle)</p> <p>Flexibility (Park anywhere, no advance-booking necessary)</p> <p>Vehicle access in urban areas (inner-city journeys)</p>	<p><b>Customer Relationships</b> </p> <p>Self-service (provide "premium" self-service through advanced application that can include customer service solutions, personalized application operated features like music, routes, addresses and network ride-sharing options)</p>	<p><b>Customer Segments</b> </p> <p>Urban residents (with short, or sporadic, vehicle demands)</p> <p>e.g. young adults and students living and working in urban areas</p>
<p><b>Key Resources</b> </p> <p>Vehicles</p> <p>Carsharing Software/System</p> <p>Range ability</p> <p>Users</p>			<p><b>Channels</b> </p> <p>Application sales and marketing</p> <p>Visible vehicles and advertizing with partners</p> <p>Website</p>	
<p><b>Cost Structure</b> </p> <p>More value oriented (competes on price, but needs to deliver additional customer value and range)</p> <p>Development, Marketing, Maintenance and Operations</p> <p>Financial services (leasing and renewable energy credits)</p>		<p><b>Revenue Streams</b> </p> <p>Pay per use (per minute, hour, day, kilometer)</p> <p>Subscription (can be used in combination with various range selections)</p> <p>Membership fee (Annual or registration fee)</p> <p>Zero emission credits (requires EV or FC PHEV)</p>		

Free-floating carsharing services allows members of a carsharing program to pick up and park vehicles at any desired location, within a specified operating area (Shaheen, Chan & Micheaux, 2015). One-way free-floating carsharing usually does not require the users make an advance reservation and a vehicle can be booked and opened within seconds. Free-floating carsharing is most suitable and efficient when used for inner-city journeys (WiMobil, 2015).










The first free-floating services began operations in the late 2000s, with the first service known as *car2Go* in Ulm, Germany (Firnkorner & Müller, 2011; Shaheen, Chan & Micheaux, 2015). As technological progress has allowed for the development of user-friendly, smartphone based solutions, this model has continued to grow and several free-floating services have been launched in both Europe and North-America. The biggest two free-floating operations are, the Daimler AG subsidiary, *car2Go*, a subsidiary of Daimler AG, which has more than 1,000,000 members and *DriveNow*, a joint venture service between BMW, Mini and SIXT, with more than 500,000 members (DriveNow, 2016; car2Go.com, 2016).

Free-floating services usually work in collaboration with city councils in order to organize pre-paid or free parking for their services, enabling vehicles to be parked wherever, in addition to increased user-convenience and continued expansion of operation area (le Vine, et al., 2014; Shaheen, Chan & Micheaux, 2015; Schmöller, et al., 2015). Urban areas struggling

with car congestion and limited parking space can benefit from offering free, or pre-paid, parking space to carsharing companies, as both parking space needed and congestion in the urban areas decline with the introduction of a free-floating carsharing service (le Vine, et al., 2014). The German study *WiMobil*, which ran from 2012 to 2015 concluded that free-floating carsharing results in parking space savings, because of a decrease of cars in the urban areas as well as a much higher vehicle utilization rate (between 80%-90% higher) than that of privately owned cars (WiMobil, 2015). The WiMobil (2015) study further concludes that the introduction and acceptance of mobility services in urban areas can help promote EVs and positively change attitudes toward carsharing.

**Station-based**

**Table 9: One-way Station-Based Carsharing Business Model**

<p><b>Key Partners</b> </p> <p>Strategic alliances between non-competitors (e.g. airline, cruise line)</p> <p>Joint venture with competitors (e.g. car rental company or automaker)</p> <p>Collaboration with alternative and public transportation</p>	<p><b>Key Activities</b> </p> <p>Platform/Network: (dependent on a well functioning network to attract users)</p> <p>Provide and operate mobility service</p> <p>Locate strategic stations of operation</p> <hr/> <p><b>Key Resources</b> </p> <p>Intellectual (brand, knowledge, partnerships, and customer database)</p> <p>Human (important in knowledge intensive and create industries)</p>	<p><b>Value Proposition</b> </p> <p>Price (offer the same product, mobility access, at a lower price)</p> <p>Convenience/usability (Convenient and hassle-free method of vehicle mobility)</p> <p>Range (better range and access to vehicle location than free-floating or P2P carsharing)</p> <p>Complementary (with intermodal transportation, or other alternative transportation)</p> <p>Flexible and spontaneous (vehicles can be pre-booked or obtained without a reservation)</p>	<p><b>Customer Relationships</b> </p> <p>Self-service (provide digital systems necessary for the users to help themselves)</p> <p>Physical customer service (Educators and sales personell, in addition to maintenance and rebalancing personell)</p> <hr/> <p><b>Channels</b> </p> <p>Own</p> <p>Direct</p> <p>Web sales (Online marketing and in collaboration with partners' online systems)</p> <p>Targeting competition (provide a more convenient service alternative)</p>	<p><b>Customer Segments</b> </p> <p>Segmented (based on user requirements, location and area of operation)</p> <p>(e.g. University/College, Intermodal transport connection, resort/vacation, neighborhood and residential, airports, business fleets)</p>
<p><b>Cost Structure</b> </p> <p>Cost-driven (minimizing costs, creating and maintaining the leanest possible cost structure, and maximized automation)</p> <p>Focus on keeping Variable Costs low</p>		<p><b>Revenue Streams</b> </p> <p>Subscription fee (Monthly or annual membership fee)</p> <p>Usage fee (charge per kilometer, minute, hour, or day)</p>		

Station based one-way carsharing is a BM where the users obtain a vehicle at one station and return the vehicle at a different station (Shaheen, Chan & Micheaux, 2015). The station-based system allows for both longer journeys, depending on the station infrastructure, and is dependent on strategic station locations rather than high user density (le Vine, et al., 2014; Shaheen, Chan & Micheaux, 2015). Station based services are usually considered less flexible than a free-floating service, but allows for more efficient destination specific journeys. Examples of locations are; to and from public transport connections or airports, city centrum and residential areas, college and university stations, to and from business campuses and

public transportation locations, in or around important business and office zones (d’Arcier & Lecler, 2014; Shaheen, Chan & Micheaux, 2015; Wells & Niewenhuis, 2015; Willander & Stålstad, 2015; Autolib Homepage 2016). Prevalent services based on this carsharing model are the *Autolib*’ project in France, *Zipcar* and *Maven* in North America.

**Round-trip**

*“Round-trip carsharing describes systems in which the user must return the carsharing vehicle to its starting point, at the end of their usage episode”*










*Susan Shaheen & Adam Cohen, 2013*

**Table 10: Round-trip Carsharing**

<b>Benefits &amp; Strengths</b>	
<i>Strengths</i>	<i>Explanation</i>
Complete Cycle	Allows for longer durations and distances, also allows the vehicle to be reserved throughout a longer journey
Long & Sporadic Journeys	Allows for sporadic journeys, and long full-day rental
Complements public transportation	Connects users with public transportation, and is still available for the return trip (home from work, university, train, etc.)
Low car needs	For users with low need for a car: students, urban residents, business use, etc.
Business and institution fleets	To and from business or institution campus



**Table 11: Round-trip Carsharing Business Model**

<p><b>Key Partners</b> </p> <p>Strategic Alliances (Car rental companies, Public transportation, Residential developers and Entrepreneurs)</p> <p>Joint Ventures (Automakers, Car rental companies)</p> <p>Collaborations (Public institutions and businesses; e.g. universities/colleges, industrial park/campus, IKEA and shopping malls)</p>	<p><b>Key Activities</b> </p> <p>Availability and range</p> <p>Recharging/refueling</p> <p>Maintaining a sufficient vehicle fleet</p> <p>Locate strategic locations, or partner with intermodal transportation</p> <p>Engage with partners</p>	<p><b>Value Proposition</b> </p> <p>Internet-enabled full-cycle car access for users with sporadic or short-term mobility needs</p> <p>Price (offer vehicle access cheaper than car rental and car ownership)</p> <p>Long or short term access</p> <p>Extended range (compared to One-way carsharing)</p>	<p><b>Customer Relationships</b> </p> <p>Online service</p> <p>Extensive Self-service system (Different charging selections; e.g. by the minute, hour, or daily fee. Also Different vehicle options)</p> <p>Physical customer service available at strategic locations</p>	<p><b>Customer Segments</b> </p> <p>Less segmented than one-way carsharing (Fleets: Urban, Residential/Neighborhood vacation/resort, and Business/Campus fleets)</p> <p>Several market segments (low-income, low-vehicle needs, business users)</p>
	<p><b>Key Resources</b> </p> <p>Vehicles</p> <p>Reservation system</p> <p>Range abilities</p> <p>Users</p>	<p>Planning-oriented (Pre-reservation, or flexible reservations during hours of low utilization)</p>	<p><b>Channels</b> </p> <p>Visible vehicles. Marketing and sales (website/smartphone application)</p> <p>Marketing and collaboration (student/business campuses)</p> <p>Online collaboration (IKEA, Wall Mart, Malls, etc.)</p>	
<p><b>Cost Structure</b> </p> <p>Cost driven (minimizing costs, creating and maintaining the leanest possible cost structure, and maximized automation)</p> <p>Fixed Costs (Location/rent, maintenance staff, software maintenance and development, vehicles)</p>		<p><b>Revenue Streams</b> </p> <p>Pay per use (per minute, hour, day, kilometer)</p> <p>Membership fee (initial, monthly or annual)</p>		










Round-trip carsharing involves renting the vehicle for both the journey to and from the desired destination, including the time spent at the location (Le Vine et al., 2014). This means that the vehicle remains reserved for the whole journey and the users are charged for the complete duration of their trip. This is in contrast to one-way carsharing, where users are simply charged for the journey and not time spent parked. However, this allow users to park the car at a desired locations and retrieve the vehicle there later, before returning it back to its original pick-up location. Round-trip carsharing can be divided into long-term and short-term journeys. Short-term-journey BMs are dependent on high efficiency and targets users looking for sporadic, excursion vehicle needs (Jorge et, al., 2015). Naturally, round-trip carsharing services can also target users with long-term demands, which require the operator to offer daily, or day-to-day, charges. Increased advance planning and reservation, are usually required for round-trip carsharing, although short notice reservations are possible at times of low utilization (Kent & Dowling, 2013; Le Vine et, al., 2014). Round-trip carsharing is also better suited for households with a low need for a car and whom does not want to pay for the “downtime”, or students whose need for a car are related to occasional journeys (Jorge et al., 2015).

## Personal Vehicle Sharing

**Table 12: Personal Vehicle Sharing**

<b>Benefits &amp; Strengths</b>	
<i>Strength</i>	<i>Explanation</i>
Efficient	Increased use of personal vehicles and low operator costs
Shared Ownership Costs	Cost of ownership is shared among several users
Social Media Integration	Social media and internet connectivity allows for easier access and increased trust among users (user rating systems)
Third-party Operated	Usually operated or organized by a third-party organization (“hassle-free”)
Geographical Range	Can operate in less densely populated areas due to lower efficiency requirement and generally consists of neighborhood fleets
Several Alternatives	Several different models to engage

**Table 13: Personal Vehicle Sharing Business Model (P2P and P2P Hybrid)**

<p><b>Key Partners</b> </p> <p>Strategic Alliance (Insurance companies, automakers, carsharing operators)</p> <p>Partners and collaboration (neighborhood community, local authorities, universities and colleges)</p>	<p><b>Key Activities</b> </p> <p>Connecting users and car-owners via social media, smartphone application, or website</p> <p>Carsharing operator: (Development and maintenance of software)</p>	<p><b>Value Proposition</b> </p> <p>Carsharing service operates with privately owned vehicles (Private cars are made available for sharing)</p> <p>Geographical range (Requires lower efficiency than conventional carsharing services)</p> <p>Benefits for users (extra earnings, higher efficiency)</p> <p>P2P carsharing operators provide "hassle-free" carsharing operations, user networks and systems</p>	<p><b>Customer Relationships</b> </p> <p>Personal contact</p> <p>Self-service (when operated by third-party systems)</p>	<p><b>Customer Segments</b> </p> <p>Segmented (Users with sporadic vehicle needs, or zero-vehicle households)</p> <p>Providers (Carowners with low use efficiency)</p>
<p><b>Key Resources</b> </p> <p>Vehicles</p> <p>Carsharing Software</p> <p>User Network</p> <p>Range of vehicle providers</p>		<p><b>Channels</b> </p> <p>Website</p> <p>Social Media</p>		
<p><b>Cost Structure</b> </p> <p>Marketing and Development</p> <p>Insurance</p> <p>Fuel and maintenance</p>			<p><b>Revenue Streams</b> </p> <p>Pay per use (Charges by the hour or daily)</p> <p>Membership fee (Annual or Registration fee)</p>	

In contrast to one-way or round-trip carsharing where vehicles are owned or leased by a carsharing operator, personal vehicle sharing involves a carsharing practice where the members of a carsharing network are granted short-term access to privately owned vehicles (personal vehicles) (Shaheen & Cohen, 2012; Shaheen, Mallery & Kingsley, 2012; Shaheen & Cohen, 2013). By enabling short-term access to a privately owned vehicle, personal operating costs for the vehicle are shared among its users and thereby reduced (Shaheen, Mallery & Kingsley, 2012).

Similar to one-way and round-trip carsharing, personal vehicle sharing models have gained traction as digital solutions and technologies have enabled easier access to carsharing services (Shaheen & Cohen, 2006; Shaheen & Cohen, 2013; DriveNow, 2015). Personal vehicle sharing motivates car owners with benefits like increased economic earnings, as vehicle owners usually receive 60-80% of the rental fee (Shaheen et al., 2012; Nabobil, 2016). The growth of personal vehicle sharing and especially peer-to-peer (P2P) services coincides with the growth of internet connectivity and social media networking (Shaheen & Cohen, 2013). Widespread internet access allows consumers to connect and share information and physical goods, like vehicles and rides (Martin et al., 2010; Botsman, 2011; Shaheen, Mallery & Kingsley, 2012).

Increased connectivity also enables collaboration between private vehicle owners and carsharing companies (Shaheen, Mallery & Kingsley, 2012). By connecting with carsharing companies and allowing them to temporarily operate the vehicle, vehicle owners can make money on their car whenever they do not use it themselves. Carsharing companies provide organizational resources like an online platform, customer support, auto insurance and booking/tracking technology (Shaheen, Mallery & Kingsley, 2012).

An advantage identified by Shaheen, et al. (2012) of personal vehicle sharing compared to one-way and round-trip carsharing companies is that personal carsharing requires a lower required efficiency level in order to be viable. This enables increased geographical range of P2P carsharing services, as it enables penetration into less densely populated areas (Hampshire & Gaites, 2011; Shaheen, et al., 2012).

#### **4.4 ANALYZING MOBILITY BUSINESS MODELS**

In this part we analyze the different carsharing BMs previously presented. The analysis will be carried out by exposing four different carsharing BMs to the emerging technologies and industry challenges we have presented and try to uncover probable outcomes of combining carsharing BMs with a new technology or an industry challenge. We will conduct a thorough analysis in order to create an overview of potential opportunities and limitations that emerges when different BMs are exposed to the different technological and industrial changes. The core findings of this analysis will be used to identify features that we suggest should be incorporated in new sustainable mobility BMs.

It is important to note that we will not define standalone strengths and weaknesses for a technology or a BM as an opportunity or limitation. We are looking to identify opportunities and limitations that arise as a result of the combination between a technology and a carsharing BM. In *impact of industry challenges*, we focus on identifying new opportunities and limitations that arise in relation between a carsharing BM and an industry challenge. If a BM strength or weakness is assumed to be enhanced under the exposure of an industry challenge, it is defined as an opportunity/limitation.

##### **Impact of New Technology**

We will start by analyzing the impact of the different emerging technologies presented in chapter two, and attempt to analyze the impacts of combining a new technology and the different carsharing BMs. In other words, we are searching to identify specific opportunities and limitations that can emerge from applying a new technology within an existing carsharing

BM. We will not analyze the impact of *connected technology* on carsharing BMs, as we assume this technology to be an essential and integrated feature within vehicles, carsharing services and autonomous driving technology.

**Table 14: Electric and Hybrid Technology**

Technology: Electric and Hybrid Technology	Carsharing Business Models			
	One-way Free-floating	One-way Station-based	Round-trip	Personal Vehicle Sharing
<b>Opportunities</b>	<p>Increased EV adoption (Reduced cost of ownership and operating costs)</p> <p>Significant reduction of GHG-, toxic-, and CO2 emissions (Variation: EV or HEV)</p> <p>Sufficient driving range (EV and HEV)</p> <p>Reduced congestion (Smaller cars and BM effects)</p> <p>Enhances effect of EV benefits ( e.g. access to free-parking)</p>	<p>Increased EV adoption (Reduced cost of ownership and operating costs)</p> <p>Significant reduction of GHG-, toxic-, and CO2 emissions (Variation: EV or HEV)</p> <p>Simplifies recharging (vehicles can be charged at stations or by rebalancing staff)</p> <p>Sufficient driving range (EV and HEV)</p>	<p>Significant reduction of GHG-, toxic-, and CO2 emissions (Variation: EV or HEV)</p> <p>Business and institutional fleet (lower operational costs and recharging at location)</p> <p>Noise pollution reduction (EVs)</p>	<p>Reduced costs of ownership (potentially higher adoption of EV/HEV)</p> <p>Reduction of GHG-, toxic-, and CO2 emissions (Variation: EV or HEV)</p> <p>Efficient for short-time or urban sharing</p>
<b>Limitations</b>	<p>Requires resources and systems for recharging/refueling</p>	<p>Investments in stations and charging infrastructure</p>	<p>Range limitations</p> <p>Charging time (on long distance/daily journeys)</p>	<p>Charging time on long distance journeys</p> <p>Requires software to ensure necessary charge for car owner use (especially an issue for short-term use)</p>

**Main findings**

The main finding for all carsharing models is *increased EV adoption*, as most of the consumers’ adoption issues and EV-technology challenges would be resolved. Consumers’ range anxiety would be solved, as one-way BMs are serving short, inner-city journeys that are

within the range of EVs. Range issues concerning low vehicle charges are solved by software that decline booking request if the vehicles' charge, is too low, or would recommend the vehicle to be charged by the user. The findings identified in this analysis suggest that EVs are far more competitive than ICE-vehicles for one-way urban carsharing due to the significant reduction in emissions and noise, in addition to enhanced usability because of the driving characteristics of EVs.

Furthermore, concerns that improvements in EV technology will leave the current technology outdated, as EVs require high initial investments and high maintenance costs, would not be an issue for users, as they have no ownership of the vehicles. Additionally, carsharing providers would be able to divide its operation cost and investments over a great number of subscribers, and their financial risk concerns would be decreased. Some of the same arguments can be used for personal sharing, where car owners would be able to reduce ownership costs, by sharing the vehicle with other carsharing members.

Secondly, equipping carsharing services with EVs results in a *significant reduction of GHG-, toxic-, and CO<sub>2</sub>-emissions*. As whole fleets of vehicles switch to electric power train technology, the resulting reduction in emissions compared to ICE-fleets would be massive. HEV carsharing fleets will reduce emissions from the vehicles, and fully-EV fleets will reduce emissions from driving to zero. Other pollution factors like congestion and noise will also be reduced by adopting EV/HEV, as these vehicles are running quieter than ICE-vehicles.

However, the current range of most EVs will still be a concern for longer round-trip journeys. Longer journeys might require re-charging, which would with today's technology result in time being spent recharging, which would be an inefficient time and money user cost.

Furthermore, in order for personal short-term sharing to be efficient and practical, it would require some sort of software that would only allow sharing and driving distances above the a predetermined battery charge limit. This would prevent personal shared vehicles to be returned without power and prevent necessary recharging before it can be used by the owner.

In addition, we initially considered adding *users' hesitation towards EVs'* as a limitation impact of EV/HEV carsharing services, but we chose not to include this factor as we believe that other customer segments would appreciate this and that it could also be considered a competitive advantage.

**Table 15: Hydrogen Fuel Cell Technology**

Technology: Hydrogen Fuel-Cell	Carsharing Business Models			
	One-way Free-floating	One-way Station-based	Round-trip	Personal Vehicle Sharing
<b>Opportunities</b>	<p>Significant reduction of GHG-, toxic-, and CO2 emissions</p> <p>Increased FCEV adoption (Reduced ownership costs and increased visibility)</p> <p>Increased driving range</p>	<p>Significant reduction of GHG-, toxic-, and CO2 emissions</p> <p>Increased FCEV adoption (Reduced ownership costs and increased visibility)</p> <p>Opportunity to operate refueling stations</p>	<p>Increased FCEV adoption (Reduced ownership costs and increased visibility)</p> <p>Significant reduction of GHG-, toxic-, and CO2 emissions</p> <p>Business and institutional fleet (lower operational costs)</p>	<p>Increased FCEV adoption (Reduced ownership costs)</p> <p>Significant reduction of GHG-, toxic-, and CO2 emissions</p>
<b>Limitations</b>	<p>Limited refueling infrastructure</p> <p>Uncertainty of hydrogen fuel costs (expensive)</p>	<p>Limited refueling infrastructure</p> <p>Investments and approval for refueling infrastructure</p> <p>Uncertainty of hydrogen fuel costs (expensive)</p>	<p>Requires refueling infrastructure</p>	<p>Limited and unknown refueling infrastructure</p>

**Main Findings**

Similarly, to what we found with EV one-way carsharing BMs, hydrogen fuel cell technology will create an opportunity for *increased FCEV adoption*, especially for services that require longer range capacity, like round-trip, and personal vehicles. For round-trip services the benefit would be that consumers would be able to drive FCEV, without having to deal with the high purchasing, hydrogen and maintenance costs. Moreover, with current consumers’ range-demands, FCEVs could potentially be a better match, than EVs, to daily commuters and users in residential and sub-urban areas with higher range and use requirements. Again, the personal sharing services would provide an opportunity for hydrogen-car owners to reduce their vehicle costs.

Unsurprisingly, similarly to EVs, another great impact of adopting hydrogen fuel-cell technology to the different carsharing BMs is a *significant reduction in GHG-, toxic-, and CO2-emissions* from the carsharing fleets.

As the current hydrogen-refueling infrastructure worldwide is poor and sporadic, there are some concerns for all carsharing services to adopt FCEV. Due to hydrogen infrastructure uncertainties, the greatest opportunity is with personal ownership or services operating in areas with an established hydrogen infrastructure. We consider one-way carsharing models to be of greatest concern as these users are dependent on widespread and close-proximity to refueling stations. Furthermore, round-trip and personal sharing services are believed to be capable of operating within the proximity of few refueling stations.

**Table 16: Autonomous Technology**

Technology: Autonomous Vehicle	Carsharing Business Models			
	One-way Free-floating	One-way Station-based	Round-trip	Personal Vehicle Sharing
<b>Opportunities</b>	BM shift: Efficient on-demand mobility service (Level 4)  Ownership substitute (for urban residents)  Increased customer base (Level 4)  Increased use-efficiency → reduced operating costs  Increased geographical range  Increased road-efficiency and safety	BM shift: Efficient on-demand mobility service (Level 4)  Ownership substitute (for urban residents)  No rebalancing limitations (Level 4)  Increased use-efficiency → reduced operating costs  Intermodal connectivity and improved convenience  Long-range opportunities with level 4	Increased road-efficiency and safety  BM shift: Efficient on-demand mobility service (Level 3 and 4)	Lev. 4: Significant rise in sharing opportunities (instead of being parked, short-journey, time-limited, etc.)
<b>Limitations</b>	Might require strategic “storage” location for excess fleet in low-utility hours. Requires connectivity (smartphone, etc.)			



### **Main findings**

The main effect when introducing AVs to the different carsharing BMs, are the opportunity for one-way carsharing services to become an actual free-floating, on-demand one-way mobility service. Autonomous carsharing fleets would allow users to book a vehicle moments before they need it, and to be picked-up at home and dropped off at a chosen destination. This would operate as an on-demand taxi/Uber service, without the need for an actual driver (Uber have already started testing their first self-driving car, CNN Money 2016). AV and connected technology would also enable efficient ride-sharing opportunities.

We believe that an autonomous one-way BM would be most successful as it has the greatest opportunities, particularly in urban areas where user density is high. By operating in urban areas the service would have access to the most potential users, the waiting time would be minimum, and the efficiency of the vehicles would be maximized. This service would require level 4 AVs. Before level 4 is available, an on-demand service would still be possible and benefit both one-way BMs. However, it would work as the current one-way BMs where users would pick-up the vehicles at widespread locations or stations in designated areas. The driving experience of urban journeys would be improved, as users would be able to sit-back and relax instead of putting any effort into congested urban driving. Level 4, one-way station-based services could also target long-range travelers and compete with intercity travels by offering larger, shared vehicles, or mini-buses, which would travel between cities.

We further identified opportunities for round-trip BMs to evolve into an on-demand carsharing service, and depending on their range-specialization could target a more residential segment. Round-trip BMs would also benefit from AVs at level 3, as users would be able to book and ride along in a self-driving vehicle, and might opt for this solution instead of a bus, taxi or other public transportation.

The main limitation we identified in adopting AV technology to one-way carsharing services is that it would require a system that distributes vehicles to available parking spots, parking garages and away from congested streets in hours of low-demand.

### **Impact of Industry Challenges**

We will continue this analysis by analyzing the potential impact of the current industry challenges on existing carsharing BMs. By analyzing the impact emerging industry challenges have on carsharing BMs, we aim to further identify features that can be used in a Mobility 2.0 BM.

**Table 17: Mature and Saturated Markets**

Challenge: Mature and Saturated Markets	Carsharing BM			
	One-way Free-floating	One-way Station-based	Round-trip	Personal Vehicle Sharing
<b>Opportunities</b>	<p>Increased possibilities for sharing (Vehicle access without ownership)</p> <p>Operates whilst reducing congestion</p> <p>Urban users</p>	<p>Increased possibilities for sharing (Vehicle access without ownership)</p> <p>Urban and residential users</p> <p>Operates whilst reducing congestion</p>	<p>Increased possibilities for sharing (Vehicle access without ownership)</p> <p>Operates whilst reducing congestion</p>	<p>Increased possibilities for sharing (Vehicle access without ownership)</p> <p>Operates whilst reducing congestion</p>
<b>Limitations</b>				Car-owner reluctance to share their vehicle

**Main findings**

The main impact of *mature and saturated markets* on carsharing BMs is the positive match and improvements that arise between this challenge and the proposed BMs. Whilst car-ownership struggles to grow in mature and saturated markets, carsharing, and especially one-way services, are growing in markets characterized as mature and saturated. Carsharing offers users mobility, without car-ownership, and provides a service that is cheaper and more convenient for many users in urban North-American cities, large European cities and congested cities in China, South-Korea, South-Asia and Australia.

**Table 18: Environmental Pressure**

Challenge: Environmental Pressure	Carsharing BM			
	One-way Free-floating	One-way Station-based	Round-trip	Personal Vehicle Sharing
<b>Opportunities</b>	Reduces emissions, congestion and other pollution  Higher adoption (Environmental awareness)	Reduces emissions, congestion and other pollution  Higher adoption (Environmental awareness)	Reduces emissions, congestion and other pollution  Higher adoption (Environmental awareness)	Reduces emissions, congestion and other pollution  Higher adoption (Environmental awareness)  Encourage to FCEV and EV adoption
<b>Limitations</b>	Requires ownership reduction amongst users	Requires ownership reduction amongst users		

**Main findings**

The main effects concerning *environmental pressure* on carsharing BMs, is that carsharing services become more attractive and they are resultantly highly sustainable in environmentally pressured markets. As carsharing eliminates emissions from driving and both provide and encourage users to become more environmentally aware, we argue that carsharing BMs will thrive under the environmental pressures impacting the automotive industry. All carsharing services reduce the combined emissions from its users compared to regular car-ownership.

Personal vehicle users would also benefit from environmentally pressured markets, as users would be attracted to these services, and car-owners would be encouraged to purchase and share FCEVs or EVs. One-way carsharing services would still require that car-owners subscribe to carsharing services, for it to be sustainable. Assuming ICE-vehicles and only non-car-owner-members, the environmental impact would be negative, and the service would not be sustainable in environmentally pressured markets.

**Table 19: Changing Customer Demands and Needs**

Challenge: Changing Customer Demands and Needs	Carsharing BM			
	One-way Free-floating	One-way Station-based	Round-trip	Personal Vehicle Sharing
<b>Opportunities</b>	Increased adoption  Digital integration opportunities  Access instead of ownership  Synergy between carsharing and alternative transportation	Increased adoption  Digital integration opportunities  Access instead of ownership  Synergy between carsharing and alternative transportation	Increased adoption  Digital integration opportunities  Reduces dependence on personal vehicle	Increased adoption  Digital integration opportunities  Access instead of ownership
<b>Limitations</b>	Demographic adoption limitations (Limited adoption rate amongst elders and middle-aged adults)  Requires urban markets  Requires connectivity	Demographic adoption limitations  Requires connectivity		Personalization reset systems (Personalized car features needs to be altered)  Requires carsharing systems  Insurance disputes

**Main findings**

From this analysis, it can be drawn that carsharing services are highly sustainable concerning the *changing consumer demands and needs*. The main impact of this industry challenge is that carsharing BMs seems to provide users with solutions that are valued by consumers with demands and needs that are not met by the current industry models. Consumers are offered access to a service, in contrast to ownership of a product, and the service is both enhanced and based on flexible and digital solutions, which modern consumers evidently to value.

Carsharing BMs also seem to encourage increased intermodal transportation and ride-sharing, which have been argued to be favored amongst users with changing demands and needs. However, the limitations of carsharing BMs in regards to *changing consumer demands and needs* is that it works best when it targets young-adult in urban and sub-urban areas and might have demographic limitations. As middle-aged and older consumers have been shown to be

reluctant to carsharing and to value car-ownership, in combination with lower digital adoption, which would limit the market segments that would be appreciate carsharing BMs. As argued, young-adults and carsharing users still continue to value car-ownership and, as previously argued, many still expect to purchase a personal vehicle as they get older. Today’s access based carsharing BMs are therefore not adequate to provide a sufficient substitute alternative to traditional car-ownership, which is the standard BM in the automotive industry and probably will remain the standard in the future.

Furthermore, as the automotive industry are moving towards providing ever more personalized vehicles and individualized-software, personal carsharing services would be dependent on systems that would temporarily reset personalized software features in personal vehicles.

**Table 20: Accelerated Urbanization**

Challenge: Accelerated Urbanization	Carsharing BM			
	One-way Free-floating	One-way Station-based	Round-trip	Personal Vehicle Sharing
Opportunities	Increased use-efficiency Reduced congestion Reduces space/land used for parking Increased market segment Targets urban users	Increased use-efficiency Reduced congestion Reduces space/land used for parking Increased market segment	Increased use-efficiency	Increased use-efficiency
Limitations	Peak hour availability	Peak hour availability	Peak hour availability	Peak hour availability

**Main Findings**

When the different carsharing BMs with the impact of *accelerated urbanization* were analyzed, we found that carsharing BMs can be a great solution to cope with the vehicle and population growth. This emphasizes the continual argument created; that carsharing services can provide access to a single vehicle to several users, and therefore reduce both congestion and the need for personal vehicles.

The second finding is that today's carsharing services have the greatest potential amongst urban users, and will help reduce congestion in urban areas. As previously argued, the world's population growth is expected to occur in urban areas and mega-cities. These are places which are already in need of solutions to reduce congestion, lack of spaces for parked vehicles and emissions from personal transportation.

The carsharing BMs presented in this analysis might be limited by the size of the carsharing fleet. A condition for carsharing services is the availability of vehicles. If the growth in carsharing subscribers becomes too high, relative to the available fleet, carsharing services would struggle to maintain an optimally balanced fleet size due to fleet requirements in peak hours. Daily commuters might opt for regular car-ownership in order to be guaranteed car-access in the morning and after-work hours.

#### **4.5 SUSTAINABLE MOBILITY BUSINESS MODEL FINDINGS**

##### **Re-energizing Automotive Business Models**










The analysis in chapter 4.4 presented us with opportunities and limitations of the current carsharing BMs, considering the new automotive technology and industry challenges. Based on opportunities from chapter 4.4 and core findings throughout the thesis, we have identified important features that we have used in order to create two alternative mobility BMs for the future.

The first, *Autonomous On-Demand Mobility*, assumes fully AVs in the near future, in addition to electric drive train technology. This BM presents an improved version of today's one-way BMs, and can serve as a prevalent alternative to traditional car-ownership for urban and suburban residents and travelers. .

The second alternative, *Sale-of-Service Personal Mobility Service*, is a BM that is based on the assumption that many consumers will continue to prefer and to be dependent on personal vehicle ownership. The vehicles used in this service will, based on the current technology, be either hydrogen fuel cell or long-range EVs, depending on the manufacturer and refueling/recharging infrastructure.

**Autonomous On-demand Personal Mobility**

**Figure 13: Autonomous On-demand Personal Mobility Business Model**

<p><b>Key Partners</b> </p> <p>Strategic alliance: Partnership between operator, hardware producer, customer database provider, IT and marketing company and vehicle manufacturer</p> <p>Cooperation: Partnership between mobility-service operator and vehicle manufacturer, car rental company and/or public transportation companies</p> <p>Joint Venture: Between provider of service or software/hardware and vehicle manufacturers</p>	<p><b>Key Activities</b> </p> <p>Problem solving (providing efficient and convenient short-journey transportation)</p> <p>Production of vehicles and soft- and hardware</p> <p>Promotion of emission-free, efficient and cheap inner-city transportation</p> <hr/> <p><b>Key Resources</b> </p> <p>Physical: vehicles, hardware and application software</p> <p>Intellectual: Customer database</p>	<p><b>Value Proposition</b> </p> <p>Autonomous urban transportation service</p> <p>Cost reduction</p> <p>Reduced dependence on car-ownership</p> <p>Accessibility</p> <p>Convenience/Usability (Flexible and spontaneous)</p> <p>Environmental friendly</p>	<p><b>Customer Relationships</b> </p> <p>Automated service: Sophisticated online and application software that enables self-service and personal customized services</p> <p>User community potential (e.g. ride-sharing)</p> <hr/> <p><b>Channels</b> </p> <p>Direct and indirect marketing</p> <p>Web sales &amp; sales by smartphone application</p> <p>Application operated</p>	<p><b>Customer Segments</b> </p> <p>Mass market: All urban and sub-urban travellers and residents</p>
<p><b>Cost Structure</b> </p> <p>Cost driven: minimizing costs by using sustainable production methods and technology</p> <p>Variable costs</p> <p>Economies of Scale: cost advantages of increased efficiency and benefit of lower bulk rates on vehicle purchase/lease and energy rates</p>		<p><b>Revenue Streams</b> </p> <p>Lending: usage fee (sale of service, fixed menu pricing), subscription fee</p> <p>Advertising opportunities within application and the vehicle</p> <p>Leasing/Licensing: to other operators</p>		

This model is based on many of the same features as today’s one-way carsharing BMs; however it assumes level 4 AVs. Autonomous EVs allows for a free-floating, autonomous mobility service that, in theory, can operate wherever allowed. This model targets urban and sub-urban residents and travelers, as highly populated areas will enable the highest possible efficiency and revenue stream. By operating a fleet of self-driving vehicles, specialized for urban use, subscribers or customers can order a vehicle on-demand, similar to a taxi or Uber service. A vehicle will drive to the desired pick-up location and as efficiently and safe as possible drive the user to a final destination, within the operating area of the service. As AVs does not require any rebalancing resources and are able to drive themselves back to central areas, the operating area of this model would be increased.

Consumers in urban areas, or with low mileage requirements, would benefit from such a service, as it would be both cheaper than car-ownership and taxi-services (including Uber-like services). In addition, this service would offer an efficient and time-saving transportation service instead of, or in combination with, public transportation alternatives. The service would be operated using a smartphone application (app) that enables on-demand booking, automatic payment, deciding pick-up and destination information, choice of vehicle model,

and additional information including pricing, news, offers, and traffic information. Payments would be made automatically by registering payment information in the app. The service fee would be charged for usage-only, which means that the customers would be charged on a per-mile, per-minute, or per-hour basis. The operator could increase revenue streams by selling advertising and multi-media features through the app or within the vehicle.

This service would reward operators and manufacturers with high efficiency, low operation costs, advanced autonomous technology, and sophisticated navigation and connectivity software. Furthermore, it can be argued that such a service would benefit from a high degree of customer satisfaction by providing convenient, safe, cheap and flexible mobility










Furthermore, operators would benefit from a large database, as more customers enable higher potential adaptation, efficiency and revenues. A high number of registered users in the same area should increase usage and thereby efficiency. The connection between efficiency and registered users further provide the argument that an extensive customer database is to be considered a key resource for this service. Companies that are in possession of, or are able to adopt or acquire, a high number of active users would have a competitive advantage to operate an autonomous, on-demand service.

Moreover, the vehicle fleet would be able to constantly vary between being parked at vacant parking spots, or drive around the city waiting to be booked. Connected technology would further enable the vehicles to not cause congestion while vacant, as they would analyze traffic information and stay parked in peak congestion hours. While parked they would be able to communicate with cars looking for parking spots, and free up slots by moving to free spaces.



**Sale-of-service Personal Mobility**

**Figure 14: Sale-of-service Personal Mobility Service Business Model**

<p><b>Key Partners</b> </p> <p>Partnerships and collaboration with developers, parts- and energy suppliers and manufacturers that enables the company to offer the best, most technological advanced, environmental friendly and sustainable vehicles as possible</p>	<p><b>Key Activities</b> </p> <p>Production: designing, manufacturing and delivering sustainable, FCEVs or EVs</p> <p>Problem solving: issues and costs affiliated with car-ownership and pressure of production</p> <p>Offer/rental individual vehicles (Connects sustainability with profits)</p>	<p><b>Value Proposition</b> </p> <p>Disruptive Performance: "Green" technology power train, better performance, atm. range issues and limited charging/refueling infrastructure</p> <p>Newness: New, convenient alternative to traditional car-ownership</p> <p>Opportunity for customization features</p>	<p><b>Customer Relationships</b> </p> <p>Personal assistance</p> <p>Additionally; a combination of automated and communities services to enhance customer relations</p>	<p><b>Customer Segments</b> </p> <p>Segmented (different vehicles and range plans for different segments)</p> <p>For urban, suburban and residential car users (with high/daily dependence on using a vehicle)</p>
<p><b>Key Resources</b> </p> <p>Physical: Vehicles, manufacturing plant etc,</p> <p>Intellectual: brand, proprietary knowledge on sustainable technology, vehicles and production, marketing and sales</p>		<p><b>Channels</b> </p> <p>Web sales (interactive and user-friendly internet-service)</p> <p>Own stores and marketing offices (in malls and other shopping locations)</p>		<p><b>Cost Structure</b> </p> <p>Value-driven: especially in the future, as customers will chose this service because many customers want to feel a connection to the company and to the environmental change(technology) and want to be a part of a movement</p> <p>Eventually; cost-driven focus, as costs need to be as low as possible in the long run</p>
		<p><b>Revenue Streams</b> </p> <p>Lending/renting/leasing: With all costs included in the subscription fee</p> <p>Fixed menu pricing: depending on vehicle model and range limit</p> <p>Financial revenue from selling carbon credits</p>		

The second future BM identified provides access to a personal vehicle, based on the limitation of customers’ continued demand for vehicle ownership and solving the user-density dependence of current carsharing practices. Thus, offering customers a personal vehicle that they rent, whilst being charged a specific fee per month. This monthly fee includes all expenses connected to car use and ownership.

This BM is based on the assumption that the mobility operator remains ownership and insurance responsibilities over the vehicle, while providing a vehicle to a customer on a monthly or yearly basis. This means that the vehicle remains with the individual customer for the entire contract period. After the contract period, the service operator can sign a new contract with another user, and the vehicle will be transferred to the new user. The newest, larger and more advanced vehicles will have the most expensive, whilst less exclusive vehicles would be cheaper. Monthly charges will decline on older and used vehicles, and by keeping vehicles in the market this service would be able to cater to customers in different price ranges.

This solution enables further complete vehicle access for customers with high mobility demands, without any of the traditional costs related to car-ownership. The traditional ownership costs, like fuel and recharging, maintenance and repairs, taxes, road tolls, and insurance, would be included in the monthly fee. We suggest a billing plan based on data subscription plans for smartphones, where the customer can choose between certain prices and mileage-included, based on the user's mileage requirements. Users who demand large amounts of miles would then choose a "plan" with more miles included each month, than a user with low mileage demands. Excess distances driven per month, would be charged with additional fees per mile. The only additional costs would be cleaning and parking fees, in places where parking charges for EVs or FCEV are not free or included.

This service would target daily commuters and residents in residential and sub-urban areas. A service like this will offer different vehicle models to cover different customer needs. In addition, the vehicles' capabilities and attributes need to be competitive with, or better, than traditional ICE-vehicles. We argue that a service like this would benefit from adopting FCEVs or long-range EVs. These technologies will allow for long-range capabilities which reduce the dependency on a widespread recharging/refueling infrastructure. Furthermore, the vehicles offered in this service need to be equipped with technology and features similar to vehicles available at regular dealerships.

However, this model assumes a simultaneous introduction of complimentary access- or carsharing services, in order for it to be a sustainable BM and to reduce overall car-ownership and cars-per-capita. If there are no co-existing complementary carsharing, or mobility, services, e.g. in the urban and suburban areas, the shift to this BM would have very little impact (Holweg, 2008).

If this model leads to a shift in the whole supply chain, it will probably provide a significant impact on the automotive industry (Wells, 2013). Whereas the traditional automotive BM rewards manufacturers for maximizing sales, increased production and by resource consumption, this alternative BM rewards manufacturers that focus on longevity, innovation and sustainability. Longevity, innovation and sustainability are met by gaining revenue from a vehicle throughout the vehicle's lifespan. The *Sale-of-service Mobility BM* rewards longevity and low operational costs, which aligns customers' and operators', or manufacturers', interests in addition to the creation of complementary environmental and social returns. Furthermore, we argue that this model is sustainable considering the industry challenges and new technology identified earlier. In contrast to today's automotive BMs, where

manufacturers' profits are dependent on increased sales and efficient production (high production), the *Sale-of-service Personal Mobility service* BM rewards companies that offer electric or hydrogen powered vehicles with competitive performance attributes, advanced equipment, low operation costs and high longevity. The longer a vehicle stays in operation, the more profitable is it. Mobility operators would additionally upgrade models and components if the newer models can provide better conditions for sustainability, and thus reward supplier, customer and mobility operator.

In order to enable this subscription model, the manufacturer and operator has to incorporate the sale-of-service model throughout its supply chain. Charging based on use, compared to charging per product, is only possible if suppliers charge the manufacturer in the same way. E.g. the tire supplier could charge the car manufacturers per mile (per tire), in contrast to a one-time charge for the product. This would expand the longevity reward identified by this model to the supply chain, as suppliers would benefit from producing sustainable and high-performing products compared to increased sales.

## 5.0 CONCLUSION

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### 5.1 DISCUSSION

#### **Discussion of Findings**

In this subchapter we reflect and further discuss the main findings of this thesis, relate the findings to relevant literature about the automotive industry in chapter two and the deduced BM theories of chapter three, and earlier research on this subject.

The aim of this thesis was to investigate sustainable mobility BMs for the future, based on the practice of selling miles, and access, rather than selling products. By identifying current issues and emerging automotive technology that are affecting the traditional automotive BM, we further identified four main challenges that a sustainable BM needs to cope with and technology that it has to successfully adopt. The different challenges and technologies are mentioned in chapter 2.1 and 2.2.

In order for us to develop potential BMs, we had to assess and define relevant BM theories, as deduced in chapter three. Nieuwenhuis & Wells (2003), Holweg (2008), Canzler & Knie (2009), Wells (2013), and Abdelkafi, Makhotin & Posselt (2013) argued that the challenges in relation with the current, inflexible structure and BM of the automotive industry were cause for concern. Our literature research described market changes and situations that the BM and structure as identified were not able to cope with the challenges facing of the automotive industry. The literature assessed further argued that the current BM was not sustainable in the future, and that the automotive industry required BM innovation in order to adopt emerging technologies and overcome the challenges identified.

The arguments presented in chapter two and three argued that the automotive industry had to change in order to successfully adapt. If the automotive industry keeps offering individual fossil-fuel vehicles to an ever growing population, the already heavy congestion in major cities will grow significantly. The environment will further be harmed by increased GHG-emissions and the automotive industry itself will keep pushing for increased sales in order to stay viable. The findings argued that the current automotive BM, under the assumptions of this thesis, is not viable and does not ensure future sustainability and growth.

These arguments received support from Christensen (1997), Margretta (2002), Chesbrough (2010), Kaplan (2012) and Abdelkafi, Makhotin & Posselt (2013), who further argue that the adoption of a new technology, or system, requires an equivalent shift in the BM to be

successful. EVs and FCEVs have too many limitations compared to ICE-vehicles by traditional benchmarks. By altering how and where to use, invest and develop the new powertrain technology, this could change the perceived limitations mentioned in chapter two and turning them into opportunities. Christensen (1997) strongly argues towards the limitations of dominant companies to change their BM and adoption of disruptive technology. The literature however, found that the automotive industry was already making alterations and is investing in emerging mobility services and disruptive technologies (Kessler & Stephan, 2013).

On the other hand, Chesbrough & Rosenbloom (2002), Johnson & Suskewicz (2009), Kley et al. (2011) and Budde Christensen, et al. (2012) argued that a radical shift towards sustainable technologies would require a radical shift in the BM. Comparatively, the literature showed that the automotive industry implemented minor changes and tweaks to the existing BM.

The research in chapter two and three further suggested that the traditional automotive BM was not sustainable facing the challenges and technological shift identified. Dennis & Urry (2009), Shaheen & Cohen (2013), Kent & Dowling (2013), Kessler & Stephan (2013) and Shaheen & Chen (2015) argued that personal ownership was causing the challenges identified in chapter two, and they further argued that offering access, rather than ownership, would be a more sustainable BM than the current automotive model. Thereby, we used carsharing's sale-of-service practices, charging for service (miles) rather than product (vehicle sales), as a sustainability foundation for the study. Access, or carsharing, was shown to result in favorable results as it reduces overall ownership, GHG-emissions and VMT of carsharing users. By developing a mobility BM for mature and developed markets based on these features, the automotive industry would be able to provide vehicle access, without having to continuously introduce and sell new models.

In chapter 4.4 we presented a thorough analysis that identified the opportunities and limitations of applying the practices from four different carsharing BMs, in relation to emerging technologies and industry challenges. The result of the analysis provided us with certain opportunities that could be used to uncover features necessary when developing the sustainable mobility BMs. By adopting *The Business Model Canvas* (Ostwalder et al., 2010), we further used the features from chapter 4.4 and developed two different sustainable mobility BMs; *Autonomous On-demand Personal Mobility* and *Sale-of-Service Personal Mobility*.

*Autonomous On-demand Personal Mobility* is a BM that operates as an on-demand, driverless, short-length transportation option for urban and suburban users. This BM would incorporate EV or FCEV technology along with autonomous technology, which can result in an emission-free, sustainable and highly efficient transportation service (comprehensive description can be found in chapter 4.5). We further suggest that this mobility service would be adoptable by both existing manufacturers and mobility operators, and it can also present great opportunities for new entrants like Apple, Google and Uber (in partnership with automakers) with their flexible organizational structure and high R&D investments (KPMG, 2015).

As a use-efficiency and customer density are a requirement for a competitive one-way mobility service, large user databases should be considered as a key resource of *Autonomous On-demand Personal Mobility*. We furthermore suggest that new entrant companies with extensive user databases will have a strong competitive advantage to successfully provide *Autonomous On-demand Personal Mobility*. Social media and digital technology companies are such potential new entrants. Today's one-way carsharing operators have relatively small customer databases compared to companies in other industries. Whereas DriveNow has 500,000 members and car2go has over 1,000,000 users, the social media and technology company Facebook has 1.65 billion users (Statista Q1, 2016), the e-commerce company Amazon has around 304 million registered active customer accounts (Statista Q4, 2016) and Apple has more than 800 million iTunes accounts in their database (Apple Q1, 2014; Forbes Investing, 2016). Moreover, financially strong companies that are strategically positioned to invest in new operations, with a large existing user database are perfect new entrant candidates to operate an *Autonomous On-demand Personal Mobility* service.

Companies such as Google and Apple have existing customer databases that consist of hundreds of millions of users, in addition to AV programs. We further predict a scenario where Google and Apple can grant access to a mobility service to all their Android or IOS users, by automatically adding an application on all smartphones using these operating systems. In addition, Apple and Google already have hundreds of million users who have connected their credit card to their iTunes/Google account, and these registered users would in such a scenario be granted access to their autonomous mobility service immediately. A driver's license approval would easily be integrated and required by the application.

Furthermore, in May 2016 Google and Fiat Chrysler Automobiles (FCA) announced a partnership, where FCA will provide vehicles to Google's self-driving car program (FCA

Group, 2016). As IT companies, would be resistant to invest in car manufacturing plants, this deal allows Google to focus on developing autonomous technology and operator software for a mobility service, while having an existing car manufacturer provide vehicles to the project. Additionally, we know that Apple is working on a similar vehicle program (Project Titan). An article by Julie Verhage at Automotive News Europe presented findings based on findings by Adam Jonas and Katy Huberty at Morgan Stanley that described Apple's recent investment in ride-sharing company Didi Chuxing as a sign of Apple positioning them for opportunities within mobility services. The article further presented findings by Jonas and Huberty that stated that Apple spent \$5 billion on incremental R&D between 2013 and 2015, which are significantly more than 14 major automakers (\$192 million)(Excluding tesla) (Automotive News Europe, 2016). We can therefor assume that the possibility of a scenario where companies like Apple, Google and Alibaba enters the mobility industry, to be significantly realistic.

In addition to this, existing automakers and mobility operators like BMW, GM, Uber and Tesla have the vehicles, autonomous technology and development capabilities to pursue an on-demand BM. Existing carsharing operators like DriveNow, car2go and Zipcar will have the required experience and organizational structure to adopt an autonomous on-demand BM. However, these companies, and other manufacturers, would be forced to compete in attracting users. In contrast, by introducing the mobility service as suggested in this thesis, new entrants as Google and Apple would be able to exploit their current member database and focus on gaining market share, increase usage, develop vehicles and build recharging infrastructure. Based on the arguments above, we further suggest that a BM similar to what we have described will be the best opportunity for new entrants to significantly disrupt the existing automotive industry.

*Sale-of-service (SOS) Personal Mobility* is a BM that, in some areas and mature markets, can operate as a direct substitute to traditional car ownership (see chapter 4.5 for a thorough description of this model). The key finding for this model is that it, in contrast to the traditional automotive BM, rewards longevity and sustainability while at the same time provides similar, or better, customer value as traditional ownership.

In order to best enable this sale-of-service model the manufacturer, or operator, should try to incorporate the same sale-of-service model throughout its supply chain. Charging based on use, compared to charging per product, is only viable and increasingly profitable if suppliers also charge in the same way. The longevity rewards identified by adopting this model

throughout the supply chain, would create incentive for additional suppliers to change, as they would benefit from producing sustainable and high-performing products.

As we were working with this idea, we came over a vehicle project called Rasa by the niche manufacturer Riversimple. The project is currently looking for funding to put their Rasa model into production. Interestingly, Riversimple is planning on using a very similar BM to the one developed in this study. Riversimple wants to offer hydrogen vehicles to users and charge them on a monthly basis (Riversimple, 2016). All costs of use, operation, development and maintenance are expected to be included in a fixed monthly fee. In contrast, we suggest charging based on a model similar to today's smartphone data plan subscriptions, where a certain number of miles would be included each month at a fixed fee and additional charges for excess miles. To discover a service based on the features and ideas we identified throughout this thesis was both surprising and inspiring.

Although we argue that the *Sale-of-Service Personal Mobility* BM identified by this thesis is similar to the BM of Riversimple, we believe that our BM needs to be adopted by larger manufacturers in order to have a significant impact on the automotive industry. The adoption of this model, or to offer it as an alternative, within a dominant manufacturer (e.g. BMW, VW, Mini, FCA, and Ford) would possibly enable a truly disruptive impact on the automotive industry.

Abdelkafi, Makhotin and Posselt (2013) argue that a change in BM would be beneficial to companies with knowledge and experience with a similar BM. Thus making companies unexperienced with the characteristics and value network of electric/hydrogen powered, sale-of-service BMs, reluctant to implement such a BM. It can furthermore be argued that this can provide an opportunity for non-automotive-actors and new OEMs to enter the automotive industry.

Both mobility BMs identified in this thesis further depend on a continuous growth of EV charging and FCEV refueling infrastructure. If the development of these technologies is cancelled due to the discovery of a superior technology, for example, the BMs in chapter 4.5 might not be adoptable for this new technology.

There are challenges to adopt the *Sale-of-service Mobility Service*, as consumers' willingness to "rent" a vehicle and use such a service has not yet been studied, and has to be surveyed before implementing the *Sale-of-service Mobility BM*. We further argue that this model, and *Autonomous On-demand Personal Mobility*, will not eliminate the need for ownership, but



will however provide an alternative model for users in certain mature markets. We acknowledge that many people consider a vehicle as an extension of people's personality, a hobby and as a collectable, and will not be attracted by the BMs identified by this study.

Moreover, as the data, research and market information used in this study is available and known throughout the industry, the BMs presented in this thesis will not be considered entirely new for any automotive experts. However, our study presents arguments and an analysis to how and why the industry should change towards BMs that are similar to our *Mobility 2.0* BM presented in this thesis.

We further acknowledge that going from ICE vehicles to EVs, or FCEVs is a development that will not happen overnight. However, we argue that the change from ICE-vehicles to EVs, or FCEVs, have started and will eventually cause great changes to markets in Europe, urban areas in North American, and in mature markets in China and Asia.

## 5.2 CONCLUSION

The main goal of this research investigation has been to identify and develop suggestions to new sustainable mobility BMs for the automotive industry. To achieve this, we started by exposing the current challenges and emerging technologies that the automotive industry struggles to cope with, or implement to its BM. By analyzing relevant BM literature and automotive industry studies, we found supporting arguments that the current automotive BM is not sustainable or applicable in relation to the changes in the automotive industry. Thus requiring new BMs to be developed that can adapt to the current changes affecting the automotive industry.

Moreover, we found that by using the sale-of-service principle, prevalent in carsharing BMs, that enable access to a service, rather than ownership to a product, we were able to identify opportunities of carsharing BMs when faced with the changes of the automotive industry. By combining new technologies with existing carsharing BMs, we found features that were used in the creation of two new, sustainable mobility BMs.

The new mobility BMs developed by this analysis are utilizing both EV or FCEV technology that makes them emission-free, and the *Autonomous On-demand Personal BM* maximize utilization of both the EV and AV technologies by targeting urban users. The *Sale-of-service BM* provide a substitute to traditional ownership that utilizes the advantages of carsharing with many of the benefits of car ownership, although without many of the costs and responsibility of traditional car ownership.

The findings furthermore show that the current level of EV and FCEV technology, especially range and recharge/refueling infrastructure, makes it difficult for these technologies to compete with ICE-vehicles. Although EV and FCEV technology can be efficiently utilized in carsharing BMs, comprehensive automotive industry BM changes or technological advancements are required in order to threaten the prevailing ownership model. However, by implementing sustainable and innovative services, as identified in this thesis, manufacturers and mobility operators can accelerate the emission-free evolution.

### **5.3 RESEARCH LIMITATIONS**

Since the automotive industry is on the threshold of potentially reinventing itself, new and important market developments, solutions and technologies have been introduced by industry stakeholders, suppliers and manufactures during the course of this semester. Some of the recent developments have affected the direction of the research in the process, and some have implied that our findings and predictions were valid and invalid. Some of the most recent market developments have confounded us, as we could predict or suggest a change on Monday, and breaking automotive news would describe a similar situation later that week. Some developments were simply too interesting, or too close to our predictions, that we struggled to keep an objective mind and may have spent too much time focusing on minor details.

We did not find it suitable to conduct our own interviews or surveys for two reasons: First, It would be difficult to arrange an interview with people of interest for this thesis and they would most likely not have revealed their plans for the future. Next, as this thesis is meant to give insight into a current and developing industry, a survey would have limited our ability to describe the most recent developments. However, if we had performed interviews with industry experts, they might have been identified and described different opportunities and limitations of the analysis in 4.4, which could have led to different findings in 4.5.

When designing our *Mobility 2.0* BMs, we developed the model specifically to cope with the identified limitations of the existing automotive BMs. The validity of our findings relies on the assumption of continued development and future adaptation of today's emerging technologies, and that the challenges are not being solved by traditional automotive BMs. The technology for a level 4 AV is still under development, and although level 4 should be developed within a few years, self-driving vehicles will face regulations and skepticism from drivers. A big concern is the issue that ethical crash choices need to be addressed and solved by the industry. As we argued that self-driving vehicles would increase safety and decrease

the potential of crashes, we decided to not include the ethical discussion in our paper. Autonomous driving, autonomous on-demand mobility and connected vehicles require comprehensive internet connectivity and smartphone access.

Additionally, it is important to remember that when analyzing BMs and making suggestions for new ones, the output (value) is only as good as the assumptions (input) that goes into it. Thus, the new BMs will only produce value to the automotive industry if the challenges identified in chapter two are true or realistic.

Furthermore, there are issues concerning the sustainability of EV and FCEV production and operating that we did not include in this study. As electricity and hydrogen require sustainable production in order to be environmentally sustainable, the overall environmental benefit from these technologies will be reduced if the energy comes from e.g. a coal plant. In addition, lithium-ion batteries used in most electric vehicles can be criticized for being hazardous and having safety-issues (Cohen, Gulbinska & Puglia, 2014). We did not include these issues as we want to identify possible BMs, and discussions around technological issues would have derailed us from the purpose of the study. Further findings by Abdelkafi, Makhotin & Posselt (2013) argue that there is a potential conflict between electricity/hydrogen providers and car manufacturers. As electricity/hydrogen opt to optimizing the number of charging/refueling stations in regards to cost, the manufacturers cannot assume their BM development on a widespread refueling/recharging infrastructure.

Finally, the lack of definitional clarity and conciseness of BM theory could potentially cause confusion and limit the research, rather than build a convergence about the BM concept and how to apply it to the automotive industry. There forth, we focused and emphasized our BM chapter on theories from a small group of researchers found in relation with automotive industry literature. The effort put into choosing BM theories could be a limiting factor to this research.

#### **5.4 SUGGESTIONS FOR FURTHER RESEARCH**

We have succinctly explained why we think companies like Apple, Google and Uber could be the companies who are going to revolutionize the automotive industry. For further research it would be interesting to analyze the organizational structures and preconditions for successfully implementing the *Mobility 2.0* into the real world.

An interesting finding is that the whole automotive supply chain needs to perform a shift towards a more sustainable mobility BM, in order not to be “Netflixed”. The existing BM

relies on after sales (parts, services etc.) and financial products (insurance, financing, and more) in order to be profitable. By altering the strategy and BM, from selling a product (part/vehicle) to selling a service, the whole incentive for “planned obsolete” is gone. Suppliers and car manufactures would be rewarded for extra longevity (the extra mile) in contrast to additional sales (additional maintenance, repairs and vehicle substitution). This could also result in a situation where suppliers and car manufactures would not need government pressure towards making their cars more fuel efficient and environmental friendly, as the car manufacturers and suppliers would profit from doing this.

Further research is necessary in order to examine the potential for both of the new BMs, especially *Sale-of-service Mobility*. In addition, we suggest that further research is conducted to examine the potential and competitiveness of new entrants that adopt one of the two BMs.

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## APPENDIX

### REFLECTION PAPER

The main objective of our master's thesis was to identify the current challenges in the automotive industry and make suggestions for new sustainable mobility business models. Our findings suggest that the future mobility business models are moving away from selling personal car ownership to selling mobility.

This topic is probably as international as it gets, as developments in the automotive industry is something that's both affecting all parts of the world and caused by international market changes. The automotive industry is changing and one cause for this is globalization. The more companies spread to new markets, the more internationalized does the industry become. Suppliers, consumers, automakers, governments and all other stakeholder are all affected by significant changes in the automotive industry, and our paper tries to provide a thorough overview over the magnitude of these changes. Furthermore, the automotive industry is causing environmental impacts that impact the whole world.

Fundamental changes in powertrain technology, use and sale of products and supply chain alterations affect most people and industries all over the world. In our thesis we identify urbanization, fragmentation of markets, changing customer demands and environmental pressure as factors that are forcing the automotive industry to change, and these are all factors that are driven by, or affecting, the international society. In addition, changes in the global economy are something that impact the whole automotive industry significantly.

Our thesis covers the whole automotive industry and emerging technologies, so there is a lot of international laws and regulations that could potentially change the output of our suggested business models. The automotive industry is highly connected to the international trends, as we saw during the financial crises in 2008. One conditions for our suggested business model is level 4 autonomous vehicles. This would mean changing regulations in some states in the US. The international environmental pressure is one of the identified challenges in the automotive industry and will affect the suggested future mobility business models.

Whatever new possibilities and solutions developed by the industry, researchers or other stakeholders can be utilized and will have a worldwide effect on the automotive industry. The automotive industry provide, more or less, provide the same product, to all people. Some vehicles are more expensive than others, some are more advanced than others, some have autonomous technology and some are made for racing. However, the product is the same and

innovation to the product or business model, will have an international impact. As we describe in our thesis the automotive industry has been providing a similar product, in the same way, as they did more than a century ago. Innovation is considered a key component of the industry; however, true and significant innovation is something that we probably will experience in the next few decades. With the emergence of autonomous, self-driving, vehicles, running on electricity or hydrogen, and utilizing product-to-service BMs, we're about to experience a whole new era of the automotive industry and the future of innovation.

As the automotive industry seek to become autonomous, digital and environmental friendly, many of the decisions and tasks necessary to drive will be operated by computers, robotics and algorithms. Driving is a complicated and difficult task, and humans are careful to implement self-driving technology. Humans also seem incapable of realizing that driving is too complicated and difficult for most of us to handle. Research provide data than self-driving technology, in many circumstances, are more capable than humans to perform most driving tasks. However, all judgements and decisions that this technology are going to make for us in the future, is going to be pre-programmed by humans, and it's therefore important that we make the right decisions for how it's going to operate.