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Tesla Motors: Disrupting the automotive industry

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Abstract

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This Work Project presents a case study about Tesla and how it disrupted the automotive industry. It concludes, that Tesla disrupted the automotive industry by challenging the predominant internal combustion engine vehicles with the commercialization of innovative electric vehicles and its infrastructure. It therefore applied several disruptive strategies. The paper is structured as follows: Firstly, a case study on Tesla is presented. Secondly, a literature review and taxonomy of disruptive innovation are introduced and applied to the case study. Finally, to conclude, Tesla´s distinctive capabilities and future challenges will be discussed.

Keywords: Tesla Motors, Tesla Inc., Electric Vehicles, Automotive industry, Disruptive Innovation

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1.1 Introduction

The anthropogenic climate change is widely recognized as one of the most serious and growing challenges in today's society. Alarming consequences are melting poles, rising sea levels and intensified weather extremes. Consequently, global warming has sparked political debates on the urgency to reduce carbon-oxide (CO2) emissions and has evoked a rethinking in society towards sustainability in the 21st century. Transportation is accountable for about 20% of global CO2 emissions. The automotive industry is a significant driver, causing about 50% of the total transportation emissions. This is primarily attributable to the predominant use of emission-intensive internal combustion engine vehicles (in the following "ICE"). Therefore alternative powertrains have evolved, the hybrid-electric engine, the hydrogen-powered fuel cell, and the battery-powered electric engine, with the aim to the aspired net carbon zero target.

Tesla Motors (in the following "Tesla"), which was founded in 2003, is an American automotive company with the goal to overcome the industry's dependence on fossil fuels through the commercialization of emission free electric vehicles (in the following "EV"). The company offers globally several innovative electric car models (consider figure 1), solar energy systems and charging infrastructure. Its models are characterized by a relatively high range, acceleration, speed, high safety, unique design and digitalization. As the pioneer of electric mobility, Tesla is the world's most valuable automotive company. With a market capitalization of 848 billion US Dollars (January 2021), Tesla's market value is even greater than the market value of its nine largest competitors combined.

Tesla has faced significant challenges while competing with the ICE standard that dominates the industry. In order to disrupt the market and define EV as the new standard, Tesla not only needs to produce EV that achieve the same performance standards as ICE, but also create a competitive infrastructure. In the remainder of this Work Project it will be outlined how Tesla managed to overcome these challenges and prevails against the established ICE automotive industry: First the paper provides an overview of the automotive industry and the transition from ICE to EV. Secondly, it provides a description of the company Tesla. Third, a short literature review of disruptive innovation is elaborated and examples are presented. Fourth, a Taxonomy of Disruptive Innovation, which focuses on disruptive strategies, is presented. Fifth, with the help of the taxonomy, it is being analyzed if Tesla disrupted the automotive industry. Sixth, the learnings and take-aways of this Work Project are summarized.

1.2 The Automotive Industry

Market size - The automotive industry, settled itself as one of the biggest and most essential industries regarding its contribution to global investments, trade and production. With an annual turnover of around 5.3 trillion US Dollars in 2017, accounts for roughly 3.65% of the world's GDP and thus can be considered a global key industry. Further significant growth is expected until 2030 with a turnover projection of 8.9 trillion US Dollars (consider figure 2).

The automotive industry grew steadily in terms of sales and production from 2001 to its peak in 2017, with exception of the years of the financial crisis in 2008/2009. While 65.92 million vehicles were sold in 2005, this figure increased by over 45% to 95.66 million in 2017. Even though vehicle sales have been declining from 2017 to 2020 by approximately 19% to 77.7 million, this development can at least partly be traced back to the corona crisis (consider figure 3). Nevertheless, experts expect continuous positive and long-term growth in automotive sales and production. Forecasts predict, that by 2030 around 145 million vehicles are expected to be sold and produced annually.

The market supply can be segmented regionally, most prominent in Asia (49.3%), specifically China (26.5%), followed by Europe (23.1%) and the USA (13.3%). The supply can be segmented into to commercial cars (2020, 31%) and passenger cars (2020, 69%) (consider figure 4).

Market attractiveness - The automotive industry is a very concentrated market. High-cost structures, and thus economies of scale, motivated car manufacturing companies to engage in intense merger and acquisition activities throughout automotive history. Accordingly, the automotive industry is nowadays concentrated in the hands of a few large multinational companies[1]. The sixth-largest corporations produce 75% of the world's automotive supply[2]. In 2020, revenue-wise, the sixth-largest competitors were the Volkswagen Group (254.1 billion US Dollars), Toyota Motor (249.4 billion US Dollars), Daimler (175.9 billion US Dollars), Ford Motor (127.1 billion US Dollars), General Motor (122.5 billion US Dollars) and Honda (121.8 billion) (consider figure 5).

The high industry concentration is also confirmed by the Herfindahl Index[3] which yields 0.71, for automotive manufacturers in 2012. This indicates the market concentration when compared to the industry average for manufacturing with 0.24. Despite the high-cost structure (figure 6), the automotive industry is still able to earn relatively stable and reasonable profits. The average net profit margin from 2015 to 2020 ranges from 3.04% to 7.29% for the sixth-largest competitors (figure 7).

The automotive industry has a very complex supply chain. While the automotive companies are increasingly taking on the main role of an automotive assembler and more production processes are being outsourced, the influence of automotive suppliers is growing (please consider left side infographic of figure 8). After the final assembly automotive manufactures then sell their vehicles online and through franchised car dealerships, whose purpose is the on-site exhibition and sale of vehicles to the consumer.

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[1] (Kapadia 2018)

[2] (Broding and Fartasch 2020)

[3] The Herfindahl Index measures the weighted market shares of companies in relation to their sales and thus indicates the concentration of an industry. (Jiayao 2016)

Emerging trends are challenging the traditional business model of the automotive industry, such as car sharing, autonomous driving, digitalization, artificial intelligence and big data. In addition, climate-conscious consumer behavior towards low-emission electric mobility can be seen as the most prominent trend. In recent years, more automotive manufactures are equipping vehicles with battery-electric powertrains instead of the ICEs (figure 4). This has created a market for EV, which will be examined in more detail below.

1.3 The Electric Vehicle Market

The growing awareness of the importance on climate change and the world's populations responsibility in reducing their carbon footprint towards a net carbon zero emission by latest 2050 has significantly impacted customer preferences in the automotive industry. In fact, EV reduce greenhouse gas emissions by up to 50% compared to ICE and are consequently a more sustainable alternative[4].

While there were 205,380 EV registered in 2012, this number grew by an impressive 5210% to 10,907,150 EV in 2020 (figure 9). Even though the market share of EV in the automotive industry has increased from 0.17% in 2012 to 2.2% in 2018 globally, this market holds a lot of potential (figure 10). The increasing popularity of electric mobility directly impacts supply chains and their production and design processes. Because of the different powertrain system, EV contain significantly fewer parts than vehicles with an ICÈ[5] (figure 11) and therefore exhibit lower maintenance costs. As a result, automotive manufacturers restructure their product and service portfolios to realize this automotive novelty. Additionally, this process is supported by large national development programs, such as EV purchasing and environmental subsidies. While 47 EV models were available in the international automotive market

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[4] (Brennan and Barder 2016)

[5] (PricewaterhouseCoopers 2019)

in 2015, this number more than doubled by 2020 reaching approximately 130 different models (figure 12). Compared to the ICE, the cost-benefit tradeoff of the more expensive EV engine coupled with a lower mileage range and longer time to recharge has resulted in customers being hesitant to make the switch to purchasing an EV. For instance, an ICE vehicle has an average range of 480 km and a full re-fill time of around 3 minutes; in contrast, an EV has an average range of 260 km and an approximate full recharge time of 30 to 45 minutes (figure 13 and figure 14). In addition, the operating costs of an EV in 2018 were on average 44% higher than an ICE car[6] and affects the customers purchasing decisions. Throughout the past years, the growing electric mobility market is most prominent in Asia, especially in China, which covers 41% of global EV production in 2020, followed by Europe and the US[7] (figure 15). Major automotive companies such as Volkswagen, Renault- Nissan- Mitsubishi, Tesla, Toyota, Daimler, Ford, BMW, Honda, Volvo-Hyundai-Kia, Jaguar-Land Rover, Mazda Suzuki, and Subaru are enhancing in the EV industry (figure 16). Daimler and Volkswagen, for example, have announced, that they will strive for a CO2-neutral future and electrify a large part of their fleet until 2050.

1.4 Tesla Motors

Tesla is considered the pioneer of electric mobility in the automotive industry. Since its founding, Tesla's goal has been to develop a battery-powered EV for the mass market that provides substantial customer benefits, such as “zero emissions”, charging flexibility, long-range, energy efficiency, high performance, all of this at low cost and at the same time having superior functionality and design. This exceptional business model differentiates them from their competitors, such as General Motors, Chrysler, or Ford, who are mostly focused on meeting the customers demand by simply electrifying their existing vehicle

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[6] (Brennan and Barder 2016)

[7] (Businesswire 2021)

models and not focusing on affordability or innovating the overall experience for which digitization is crucial.

1.4.1 History of Tesla

Tesla's successes of becoming the most valuable automotive company in the world, is tied to an interesting development. In the following, the company's history is presented in chronological manner (consider figure 17- infographic of Tesla's history timeline).

Marc Tarpenning and Martin Eberhard founded Tesla Motors ("Tesla") in July 2003 in Palo Alto, USA. In 2004, Elon Musk (figure 18: Excurse - Elon Musk) joined the company as a chairman and cofounder. As Musk emphasized, in order to enter a mature market, Tesla´s products had to be novel and superior compared to its competition to create a customer switching and buying incentive[8]. Tesla focused on the development of EV and, as such, increasing R&D expenses had been realized (figure 19). The first Tesla model, the Tesla Roadster, was developed in collaboration with electric car manufacturer AC Propulsion and the sports car manufacturer Lotus. The 2008-launched Tesla Roadster proved to the market with its exceptional performance features - a range of 350 km, a top speed of 201 km/h – the concept of a fully electric vehicle. In 2008 Elon Musk became CEO of Tesla. The company benefited from establishing some essential strategic alliances in 2009.

In that year, Tesla reached agreements with Daimler and Toyota to supply both companies with powertrains and benefit from financing and knowledge exchange. Another crucial strategic partnership was with the Japanese electronics company Panasonic to develop and manufacture advanced and revolutionary lithium-ion battery technology for EV. This solved range and battery lifetime issues of EV. In 2010 Tesla had its IPO. In line with Tesla's product strategy of gradually moving from the luxury

[8] (Musk 2017)

segment to more affordable models, the Tesla Roadster production was discontinued in 2012. Instead, Tesla's Model S went to market as a high-class limousine. These highly digitalized full-electric 5+2 seated family sedan started at 57,400 US Dollars and could range up to 610 km on one charge. The Model S became Tesla's flagship and determined how all subsequent models would be perceived: As one of the first luxury EV limousines, it competes directly with luxury sports cars in terms of performance (figure 20). Additionally, it also focused on digitalization. Large 17-inch touchscreens were used to create new functions, an interactive interface and a unique customer experience. Revolutionary functions at the time, such as automatic parking and autopilot, were also added. Due to the reduced use of parts, the high form of digitalization and the connectivity, software optimization took on a new significance.

By 2012, Tesla already had more than 900 patents. To induce other car manufacturers to join electric mobility, Tesla released its patents and provided free licenses for many of its technologies. In addition, to the development of EV' hardware and software, another aspect of Tesla´s strategy was the development of distribution, service and charging infrastructure, which grew along the way in North America, Europe, the Middle East, Australia, and Asia (25,000 Supercharger). In the first quarter of 2013, Tesla recorded its first profit (figure 21). While in 2014, Tesla and Panasonic announced its construction of the first Gigafactory, a large-scale battery manufacturing plant, in Nevada, USA. During that time period, many big companies such as Google, Apple, Daimler and Tesla pursuit intensive research efforts in autonomous driving cars. However, in 2015, Tesla became a pioneer by commercializing autonomous driving capabilities. In the same year Tesla introduced its Model X, which is considered a premium SUV staring at a price point of 85,000 US Dollars and a range of 320 miles.

Finally, with its acquisitions of SolarCity (production of solar panels and home energy storage systems) and Grohmann Engineering (manufacturing automation - robotics) in 2016, Tesla expand its product portfolio with Tesla Energy and Tesla Grohmann Automation. Tesla Energy leverages SolarCity's knowhow combined with its knowledge of battery and software technology to offer cost-effective solar panel leasing options in conjunction with smart, off-grid solar power storage systems. Tesla even uses its solar energy capabilities to power certain Supercharger stations and manufacturing facilities. In 2017, Tesla presented the prototype of the Tesla Semi, an electric-powered cargo truck. Tesla introduced some additional models in 2019, 2020 and 2021: Since 2019, it offers its most affordable model 3 for 35,000 US$, a digitalized family sedan with a range of up to 507 km. Further, Tesla introduced the Cybertruck, a premium futuristic-looking pickup truck that should enter the market in 2021. In addition, in 2020, Tesla launched the Model Y for 49,990 US Dollars, a SUV-Crossover with a range of 450 km.

Tesla could constantly increase its vehicle production, while in 2012, it delivered 2,600 vehicles and in 2020 it achieved its milestone of producing 500,000 cars annually (figure 22). Revenue grew from 117 million US Dollars in 2010 to 31,536 million US Dollars in 2020, and due to investments in its R&D and infrastructure 2020 Tesla was able to achieve a profit for the first time (figure 23).

The astonishing development from a start-up company to an established automobile manufacturer was reflected in its stock price. In January 2020, Tesla became the most valuable US car manufacturer and, in January 2021, the most valuable automotive company in the world with a closing stock price of 883.09 US dollars, corresponding to the company’s highest market capitalization of 847.77 Billion US dollars.

1.4.2 Key Resources of Tesla

Tesla has managed to differentiate itself from the traditional business model of an automobile manufacturer through various key resources, bringing innovation and change to an old and concentrated industry. Decisive factors in this regard will be highlighted in the following.

1.4.2.1 Batteries, Software and Technology

Batteries - Battery technology occupies a crucial role in the EV market due to its high share of total costs (consider figure 24) and customer acceptance in terms of range, safety concerns and charging time.

While most existing EV were based on lead-acid cells, Tesla, in cooperation with Panasonic developed the unique technology of Lithium-ion batteries for EV. Higher efficiency and greater capacity lead to a longer lifespan and increasing range of EV. As such, EV that have an average range of 235-480 miles could now compete with ICE cars, which have an average range of 480 km. However, Lithium-ion battery packs can take up to 50% of EV total costs.[9]. To reduce its costs, Tesla tries to achieve a cost advantage through Economies of scale. Tesla decided in 2017 to build its first Gigafactory in Nevada, USA with a production capacity of 500,000 batteries annually. Consequently, the Lithium-ion battery price could be significantly reduced. While in 2010, the average lithium-ion battery price was at 1,191 US Dollars per kWh, it declined by 88.5% to 137 US Dollars per kWh in 2020 (consider figure 25).

Software and Technology - Tesla's endeavor to digitize the car is highlighted when Elon Musk described Tesla as " (…) a software company as much as it is a hardware company" and refers to its vehicles as " a very sophisticated computer on wheels "[10].

Tesla built its hardware architecture from the ground up for electric powertrains in conjunction with many software elements. For instance, smart dashboard touchscreens, energy-efficient route planning, shopping, instant car-sharing, and third-party app support ensure a digitalized automotive experience. Further unique interconnected systems help Tesla constantly monitor the data of its customers' vehicles. As a result, a constant wireless internet connection of its cars is ensured through Tesla´s multiple collaborations with wireless carriers. The associated mobile app helps the owner remotely to locate, charge, lock, air condition and even park the car. Furthermore, over-the-air software updates, diagnostics,

[9] (Niese and Pieper 2020)

[10] (Musk 2015)

repairs, and Big Data collection keep the Tesla vehicles at the cutting edge of technology. Gathered data is then used to optimize the car, find new locations for stores, supercharging stations and service centers, as well as enhance R&D endeavors such as autonomous driving. Accordingly, Tesla was the first car manufacturer to commercialize automotive driving capabilities in its cars[11].

Due to the high use of software integration to its fleet, Tesla´s cars are also more customizable than conventional ICE cars. Hence, customers can manipulate various controls, for instance, driving assistance, suspension settings and driving analyses details. Through its hardware-software architecture, Tesla has succeeded in creating a futuristic car that can add value for the customer even after purchase (e.g., through over-the-air software updates) and strengthens the connectivity between its users (e.g., through app connection) and the environment (e.g., through autonomous driving or smart charging station route planning).

1.4.2.2 Infrastructure and Networks

Tesla has created an innovative international manufacturing, service, distribution, and charging infrastructure network for its EV to be functional and competitive.

Manufacturing- In order to compete with its large competitors, Tesla scaled up its production to achieve Economies of Scale. Accordingly, Tesla engaged in a fast international expansion of its manufacturing facilities. In 2010, Tesla acquired its first factory in California, USA. The so-called Fremont factory was part of the alliance that Tesla formed with Toyota and can produce an annual capacity of 500,000 cars. In order to keep up with its optimistic expansion plan, Tesla introduced the concept of its “Gigafactory”. Gigafactories are large-scale and highly automated manufacturing sights that can cost over 1 billion US Dollars. With areas of up to 180,000 square meters, these factories are among the largest buildings in the

[11] (Tesla 2016)

world. Next to short construction times of 1-3 years, these factories are solar-powered and designed to be energy neutral. They are characterized by incorporating as many production stages as possible in order to achieve cost and process efficiencies. For international expansion Tesla uses its gathered customer data to locate its Gigafactories in strategic positions. Tesla created an international network of five Gigafactories in the USA, China and Germany (consider world map of factories- figure 26):

With the increasing need for battery packs and powerpacks, Tesla decided to build its first Gigafactory in cooperation with Panasonic in Nevada (USA). In the same year, the second Gigafactory opened in Buffalo (USA), intending to supply solar and charging infrastructure. In 2019, Tesla opened its third Gigafactory in Shanghai (China), which expands capacity by 500,000 cars annually to supply the big Asian market. The fourth Gigafactory will be located in Berlin-Brandenburg (Germany). In summary Tesla grew to big vehicle-, solar-, and charging station- manufacturing capacities.

Service and Support – A unique feature of Tesla compared to other established automotive companies is its superior service and the well-developed service network. Hereby, it can capitalize from the connectivity of its fleet; consequently, over-the-air software updates, diagnostics, system checks and repairs can be carried out. Additionally, Tesla also offers 24-hour roadside assistance with a fleet of 743 service vehicles. Consequently, the worldwide distributed 518 service centers (as of 2021) (consider service center world map -figure 27), can scheduled appointments efficiently, readout online diagnoses of the cars and order parts in advance. The generated car data is also used to optimize the location of the service centers.

Sales and Stores – Compared to conventional car dealerships, Tesla takes an innovative approach to sales based on education and customer experience. Tesla does not employ salespeople in the traditional sense, but rather product experts trained to educate customers about electric mobility and products. Tesla's products are ordered exclusively online through a highly interactive website. Tesla has established its own network of 438 Tesla Stores around the world (consider store world map - figure 27). These are mainly located in high-traffic and visually appealing locations, e.g. shopping malls. Similar to the consumer electronics industry, the stores have a minimalist design (consider figure 28).

Charging Infrastructure - Even though EV could be charged from home, long-distance travels require a charging station network in order for the EV industry to be competitive. Consequently, Tesla developed the EV fast-charging station network, the so-called "Supercharger" stations. While certain models could use charging infrastructure for free, Tesla advertised that a full charge fee was approximately 25% cheaper than a comparable tank fill of an ICE car. In addition, Tesla's Superchargers offer customers a faster alternative to home charging, reaching 80 percent in as little as 30 minutes. Tesla installed its own Supercharger network with more than 20,000 Superchargers until 2012. Tesla started with the West and East coast of North America, then connected both and further extended their charging Network to Europe, the Middle East, and Asia to a total of over 25,000 Superchargers in 2021[12] (consider figure 27).

1.5 Challenges of Tesla

Many automotive companies are turning towards e-mobility, which implies challenges for Tesla, e.g., the VW Group is planning over 70 new EV models by 2030, Toyota wants to electrify 50% of its models by 2030, Jaguar wants to fully electrify from 2025[13]. In the Asian region competition is growing rapidly with companies such as Geely, BYD and Nio. But also large software companies, expressed their interest in the automotive industry: Google and Uber are researching on autonomous driving capabilities. Apple is developing the Apple car, which launch is scheduled in 2024. Accordingly Tesla faces intensifying competition, not only on the "hardware side" but also on the "software side" of its current business model.

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[12] (Tesla 2021a)

[13] (Tyborski, Fasse, and Hubik 2020)

More recently, the Covid-19 Pandemic has stuck, and automotive revenues are expected to decline by 20% post-crisis (figure 29). In addition, other alternative powertrain concepts, such as the fuel cell, could become a challenge to EV in the future. Finally, EV have been criticized more often due to missing battery recycling systems and unsustainable raw material extraction in developing countries. As such Tesla and the automotive industry are facing other challenges to overcome.

2 Analysis

2.1 Definition of Disruptive Innovation

Tesla disrupted the automotive industry. However, there are several definitions in the literature of disruptive innovations. Clayton M. Christensen introduced the concept of disruptive innovation, which deals with the question of how small company's innovations/technologies, which initially appeared only in specific market segments, could challenge competitive market structures or even cause new markets to emerge or collapse (Bower and Christensen 1995). Rafi & Kampas (2002) and Christensen, McDonald, Altman and Palmer (2018, 4–5) define disruptive innovation highlighting the cost and functional quality of an innovation to meet customer needs. They define a disruptive innovations as the introduction of a novel product, service or technology in an established industry, which performs better and at a lower price point than the existing offering. Hence, “disruption describes a process in which a smaller company with fewer resources is able to successfully challenge established companies” (Christensen, Raynor, and McDonald 2015, 46). Theoretically, the initially inferior disruptive innovation gradually improves until eventually it finally competes with incumbents’ products. Hence according to Christensen, due to its superior cost or performance measures, the disruptive innovation starts to push incumbents out of the market and thus have a lasting impact on industry structure (Bower and Christensen 1995 ; Rafii and Kamaps 2002). Christensen argues that large incumbents usually have little motivation to reallocate resources, e.g. to invest in new and small markets, because the risk of cannibalizing their functioning and usually profitable business model is considered too high. On the other hand, small companies with their usually developing business models and a more agile internal resource allocation process, tend to be more willing to take these economic risks (Bower and Christensen 1995, 51). Therefore, Christensen et al.(2015) associate disruptive innovation as mostly introduced by small firms. In contrast, other authors define the origin of disruptive innovation more broadly, as they do not specify a particular company size in this context:

Danneels (2004) and Tellis (2006) define disruptive innovations from the perspective of market characteristics, such as changing consumer expectations and market metrics. Accordingly a customer's preference for a particular product is based on the customers' needs, which in turn define the competitively relevant performance attributes of a product, service or technology. Accordingly, different customer groups value different product attributes and thus form different market segments. Since the formed performance attributes are limited by the underlying technology, each technology thus forms a limited framework within which a market moves. Consequently, Danneels and Tellis define disruptive innovations as products, services or technologies that introduce new dimensions of performance attributes at which prior established products did not compete. As such, disruptive innovations have a lasting impact on the fundamentals of competition in an industry (Danneels 2004; Tellis 2006).

Similarly to Bhalerao and Dr. Deshmukh (2019), who consider disruptive innovation as "(…) an innovation that creates a new market and value network and eventually disrupts an existing market and value network, displacing established market leaders and alliances". This paper defines disruptive innovation as a new product, service, technology or business model that replaces the previews generation in the market, making it obsolete or irrelevant. Furthermore, disruption is considered an evolving process and hinges on the interaction of the market (Markides 2012).

2.2 Examples for Disruptive Innovations

An example for a disruptive innovation is Netflix and how it disrupted the movie rental industry with its online streaming offering.

In 1997, Blockbuster Video was the largest video rental business in the world. It rented movies in its stores in the form of cassettes or DVDs for a fee to its customers for a certain period of time.

When Netflix launched in 1997, it offered a subscription-based online video rental service and had unlimited movies send to them via US mail. However, new technologies enabled Netflix to move to Internet-based video streaming. Thus it offered high quality content, higher convenience and at lower prices on demand. Netflix sparked a video streaming boom and became known as one of the largest video-on-demand platforms, while Blockbuster, the former giant with its outdated movie rental business model, went bankrupt in 2010. Netflix's online streaming service was thus a disruptive innovation that revolutionized the movie rental market and pushed Blockbuster out of the market (Christensen, Raynor, and McDonald 2015).

Another example of a disruptive innovation is, how Apple revolutionized the cell phone market with its iPhone in 2007. In the 2000s, the Finnish technology company Nokia was considered the founder of the conventional cell phone and established itself as the market leader in the mobile phone market. When Apple Inc., which was initially insignificant in the mobile communications market, launched its iPhone in 2007, it established a new market standard - “The smartphone”. Screens and keyboard-based controls of conventional mobile-phones were replaced with capacitive touchscreen and a user-friendly desktop-like operating system. Due to its internet connectivity and platform technology such as the App Store, the smart performance of the iPhone was superior in fulfilling customer needs. Consequently, this disruptive innovation ensured that Apple could displace Nokia as the market leader and changed the mobile communications market substantially (Cuthbertson, Furseth, and Ezell 2015).

2.3 Taxonomy of Disruptive Innovation

*In the following we propose a Taxonomy of Disruptive Innovation, please consider **figure 30** for that.*

I tried to come up with a taxonomy, which tries to encompass most disruptive strategies. In order to do so academic literature has been revised (figure 31). It is to mention that this taxonomy is not exhaustive, as there are many ways to be disruptive. In fact, this taxonomy attempts to add value to companies by capturing the most common strategies for how companies can be disruptive. Therefore, this taxonomy can be useful for companies when thinking about on how to disrupt an industry and/or on how they can defend themselves against potential disruptors.

To explain the Taxonomy of Disruptive Innovation (please consider figure 30), some of the most common strategies, that companies use to be disruptive, will be explained in the following:

(1) Many of great disruptive business models lie in the interface between two industries. For instance, Apples smartphone the "iPhone" stands in the interface of the personal computer industry and the mobile phone industry and similarly, the Nintendo Wii, connected the gaming and fitness industry (Rasool et al. 2018). Hence many disruptive innovations have eliminated industry boundaries. (2) Another strategy for companies to be disruptive is to create new business models through virtualization, automation, digitization and/or disintermediation (the process of reducing intermediaries). As already mentioned by offering online streaming Netflix disrupted the movie rental industry through its new business model (Richardson 2011). While customers used to have to rent films physically, this process could be simplified by an online platform (virtualization and digitization of film rental) where films could be streamed automatically on demand (automation), making distribution centers or stores redundant (disintermediation). (3) Additionally, Bundling and unbundling is the process of tying or splitting a product into individual parts or combining them into one product or service. This generates often higher levels of customization and therefore increase the customer satisfaction. This strategy can change the

customer experience and have a disruptive effect. For example, Spotify, a music online streaming service, changed music industry disruptively by offering flexible music streaming on demand, instead of the buying option of CDs with physical bundled Songs (Fox 2014). (4) In addition, a common disruptive strategy is to enrich the product with information, social content and connectivity. For example Apple enriched the iPhone with connectivity (e.g. Internet/Bluetooth connectivity, cloud-storage-network (iCloud), with social content (e.g. through free communication apps for iPhone users such as Facetime or IMessage), and information (e.g. with fitness or screen time tracking apps) (Pisano 2015). Among other things, this strategy led to the disruption of the traditional smartphone, which was not able to perform on these performance metrics. (5) Similar disruptive strategies are often characterized by Sharing Economies. Sharing Economies are often marked by the sharing and exchange of resources between individuals and their collective use on platforms (usage without ownership). For example, the content of the online encyclopedia Wikipedia is written by its users for its users. It is therefore a sharing economy in which users can exchange knowledge collectively. Through this collective intelligence, Wikipedia.org was able to build up a huge, continuously updated pool of knowledge in a very short time. These advantages helped it to displace the printed encyclopedia industry (Flavin 2021). (6) Further by targeting the product or service on non-consumers, companies can disrupt. For example, the Nintendo Wii disrupted the gaming industry, by connecting gaming with fitness, and therefore targeting sportive consumers (Rasool et al. 2018). (7) Many disruptive strategies are based on lean business models and operational efficiency in order to create lower costs alternative. In order to supply a lower priced and affordable mass-market product, disruptors tend to reduce inefficiencies in their business model and hence create a more affordable product. Southwest Airlines, for example, have disrupted the airline industry with business model innovation. By offering a customizable minimum set of services, they were able to offer significantly cheaper flights than its competition (Christensen et al. 2006). (8) Another strategy on how to be disruptive is by leveraging customer relationships and information through hyperscaling platforms. Owners of such, utilize operating leverage from network effects, process automation and algorithms created from its huge number of customer interactions. For example, the social media platform Facebook connects over 2 billion customer profiles. Hereby it capitalizes on the gathered customer information through automated process and algorithms to provide value to its customers. Through this platform Facebook was able to disrupt many industries such as the advertising industry with social media marketing (Dawnson, Hirt, and Scanlan 2016). (9) Companies can be disruptive by providing new markets as market makers, hereby creating new interfaces for linking supply and demand. An example of this is eBay. The online platform established the marketplace for online auctions of new and second-hand goods. It is considered today as the pioneer of e-commerce and connected the supply of online traders with the demand of online customers through its platform (Rakic 2020).

2.4 Did Tesla disrupt the automotive industry?

Tesla's underlying disruptive strategy is to challenge the status quo of the automotive industry, by creating unconventional and disruptive concepts that constantly challenge the existing market structures of the automotive industry. In this respect, Tesla knows well how to capitalize on its disruptive strategies to create unique selling propositions and to capitalize on the resulting synergies.

While the automotive industry responded to the sustainability trend only by continuing to optimize internal combustion engines, Tesla created alternative through the commercialization of its “zero emission” EV(Furr and Dyer 2020). Hence, Tesla's fundamental disruptive strategy was to replace the ICE with an electric powertrain based on their superior battery technology (long lifetime, high range). However, another disruptive strategy of Tesla was to challenge the conventional corporate structures of automakers, by providing for the supply of an EV centric infrastructure. In addition, while the vehicles of the automotive industry were mainly hardware based, Tesla's was able to disrupt through software integration, digitalization, virtualization, connectivity and Artificial Intelligence in its EV. Accordingly, Tesla disrupted the automotive industry, with the use of multiple disruptive strategies (please consider the Taxonomy of Disruptive Innovation (figure 30):

First, Tesla engages in the disruptive strategy of creating a new business model through disintermediation - By being highly vertical integrated in its supply chain, Tesla gets rid of many intermediaries therefore creates a new business model, where customers not only buy a car, but also the "license" for a whole infrastructure. Tesla achieves a much higher vertical integration than its automotive competitors (consider figure 8). Tesla relies on fewer suppliers in its manufacturing process. The assembly of its products (vehicles, superchargers and solar systems), is produced inhouse including the solar power required for the production. This enables Tesla to disintermediate various intermediaries, reducing the complexity of its supply chain and increasing procurement and quality control (Chen and Perez 2018). Further, Tesla has a unique sales concept. This relies on online sales in combination with company-owned retail stores, that focus on customer product education rather than just sales. Tesla does not rely on third-party dealerships as conventional automakers do. Similarly, Tesla's in-house service structure, with service centers and 24/7 roadside assistance, gives it the ability to differentiate itself from third-party providers.

By the strategic decision, to build its own Supercharger infrastructure, Tesla eliminated its dependence to rely on other suppliers to build new or adapt the existing car refueling infrastructure.

Consequently, through the supply of an international infrastructure of charging stations, service support and distribution, Tesla provides its EV with higher usability, competitiveness and capability for the mass market use. Through the high vertical integration of the value chain and the associated disintermediation, Tesla is creating a new business model based on value creation along the entire supply chain and close customer interaction through missing intermediaries. Unlike the status quo of the automotive industry, Tesla creates thereby a situation where the customer not only buys a car but also gets universal access to the associated infrastructure (e.g. Tesla model S (before 2017) free charging for lifetime). Overall, the creation of an infrastructure hence disrupted the automotive industry significantly.

Second, Tesla was able to act disruptively by <u>eliminate industry boundaries of the hardware and software industry</u>, by creating "smart" EV - This gets even clearer, when Elon Musk stated that Tesla is equally a hardware as well as a software company and that its vehicles can be considered a computer on wheels. This gets clearer when considering third, fourth and fifth disruptive strategy Tesla used.

Third, Tesla disrupted through the <u>disruptive strategy of digitalizing, virtualizing and automating</u> its vehicles - While the vehicles of conventional car manufacturers were equipped with a lot of hardware (buttons, knobs, switches), Tesla began to digitalize and visualize the car´s interior. This is mainly attributable to its strong integration of software in its automotive hardware and allowed Tesla to integrate a highly visualized and digitalized user interface, with large touchscreens, interactive operating systems, highly interactive apps and digital features (e.g. over-the-air software updates) (Tesla 2021b). Further, the software and hardware architecture of Tesla´s EV, enabled autonomous driving capabilities, which automated the driving process for its customers. The software use with Artificial Intelligence enabled Tesla´s EV, in interaction with the uses of radar, cameras and ultrasonic sensors, to detect and react to the car´s environment (Tesla 2019). This disruptive strategy generated for Tesla unique selling proposition, as competitors were unable to compete with the performance metrics that Tesla had created.

Fourth, Tesla disrupts by higher <u>customer satisfaction through higher customization of its EV</u>-

Further the high digitalization offers cars with greater customization capabilities. For example, Tesla customers can create a personal vehicle profile, in which the customer can use the large touchscreens to tailor the instrument panel layout, driving characteristics and chassis settings to their needs. Accordingly, compared to conventional automotive companies, that mainly relied on fixed hardware interior, Tesla´s is able to generate higher customer satisfaction through customization.

Fifth, finally Tesla uses its disruptive strategy of enriching its EV´s with information and connectivity- Through its collaboration with telecommunication carries, Tesla´s EV have a 24/7 3G internet connection (Tesla 2020), enabling Tesla to capitalize its software architecture even further. By offering over-the-air updates, service support and diagnostics, it relieves the customer of time-consuming initiative and provides value creation throughout the EV life cycle (e.g. through system updates). In addition, Tesla also constantly gathers the customers information to optimize its software, as well as its networks of service centers, charging station and stores (based on the gathered GPS data). Hence, through Tesla's connectivity strategy creates an additional performance metrics at which competitors were unable to compete due to their technological deficits.

In 2015 only about 47 electric models were available on the market. This number is projected to exceed 330 models by 2025 (consider figure 16). This, combined with the willingness of leading automakers to fully electrify their fleets between 2030-2050 (Motavalli 2021), demonstrates the disruptive impact that pioneering Tesla has had on the automotive industry and makes the ICE obsolete. Thus, by our definition, Tesla with its innovative business model can be defined as a disruptive innovation in the automotive industry.

3 Conclusion

3.1 Distinctive Capabilities and Challenges of Tesla

Distinctive capabilities – Summarizing, Tesla has a competitive advantage by being disruptive and several distinctive capabilities played a significant role in its disruption of the automotive industry.

Tesla has been able to develop several distinctive capabilities that sets it and its product apart from its competitors, creating a competitive advantage and even further disrupting the industry of its competitors.

Firstly, the most significant disruptive component was the consistent commercialization of the EV, in an automotive industry increasingly burdened by the climate crisis. This was possible through its unique battery technology and production. Through its unique long-range Lithium-ion battery-cells, Tesla is able to create EV which outperform any of its competitors´ products and even compete directly with the performance of conventional ICE. This distinctive capability has had a major impact on the customers perception of EV as feasible alternative to the ICE. Moreover, due to its massive and scalable inhouse production facilities, Tesla has been able to produce a key component of the EV at very competitive cost that it translates directly to its customers, making its EV models affordable and competing directly with ICE. This is particularly remarkable, since Tesla understood early on, that in order to enter, disrupt and dominate the market it would have to develop the ability to produce key components such as battery-cells far below the then-current market prices, which was only achievable through vertical integration to generate economies of scale in production. Secondly, Tesla´s software development knowhow and its high integration with its hardware, distinguishes its products to the ones of its competitors. It enables Tesla to provide much more virtualized and digitalized vehicles compared to its competitors that do not have comparable software know how. Furthermore, Tesla understood that the interconnectedness of hardware and software would become key in the automotive industry and that superior software development would be one of the most distinctive capabilities to drive its competitive advantage. Hence, Tesla achieved to integrate autonomous driving capabilities, state of the art sensor technique and big data analysis into its cars, turning them into high-powered software processing units. The information produced by its sold vehicles generates a highly valuable data pool for Tesla, enabling it to optimize its software and infrastructure based on real time information.

Finally, a distinctive capability is its vertical integrated supply chain and the related service and charging infrastructure. Its distinctive vertical integration includes the sourcing of key assembly components such as battery cells guaranteeing independence as well as cost and quality control; the inhouse sales process that increases its margins; and continuous further downstream with service support, charging stations and even sustainable energy solutions that customers can deploy at home. Tesla can capture a lot of value and can thus follow a production process in which the product can be efficiently developed around the customer's needs.

Another fact is, that Tesla is not just selling an EV to its customers but an entire product experience, including its large international charging and service infrastructure. Its information-based optimized network of over 25,000 “Supercharger” stations is incomparable to any of its competitors. Overall, Tesla disrupted the automotive industry.

Tesla´s disruptive strategy thus goes hand in hand with its distinctive capabilities, that individually and jointly constitute the disruptive effect that Tesla had on the automotive industry. Because Tesla is not just a car manufacturer but much more an e-mobility company offering a much higher value proposition to its customers than just a simple EV, could be an explanation for why shareholders value Tesla's market capitalization with 848 billion US Dollars, significantly higher than that of its competitors.

Challenges - Tesla is also facing several challenges in the future. On the one hand, many big automotive companies such as the VW Group, Toyota, Jaguar, have already announced that they want to electrify their fleet in the next 10 to 30 years. For Tesla, this means in the long-term an intensification of competition in the EV market. These electrifying automotive companies can build a compelling service, distribution and charging network by capitalizing on their existing infrastructure, e.g. by capitalizing on their existing international infrastructure (e.g. charging stations at car dealership locations). On the other hand, another big challenge is the rising competition on the software side. Many big software companies, such as Google and Uber are investing in autonomous driving, but also Apple announced to join the automotive industry in near future. If these big software companies can leverage at their existing competitive advantage, such as, hardware software integration, artificial intelligence or big data, and decide to join the EV market, or form strategic alliances with established automotive companies, this could become a significant threat for Tesla to sustain its competitive advantage regarding its software capabilities. Accordingly, Tesla must continue to build on its distinctive capabilities and leverage its current market leadership to secure its future market position.

Tesla so far can be seen as pioneer of the EV manufacturing but its first mover advantage will soon be diminishing. Tesla needs to define clear strategies of how to position its brand in the market to successfully compete for customers in an increasingly competitive market environment.

With increased competition, the processing speed and analysis of Big Data and related fields such as customer analysis, customer service and support and also autonomous driving will gain considerably of importance. Tesla has been one of the first companies to implement data collection in its fleet. Consequently, Tesla should continue to focus to be a market leader, e.g. regarding data collection and analysis, to successfully gain a competitive advantage in this field over its competitors.

3.2 Discussion

This paper concludes that Tesla with its innovative business model can be considered a disruptive innovation in the automotive industry. However, it should be noted that the result of the analysis can only be as good as the underlying data/information. Some strategic aspects of the company were not considered, such as marketing, H&R and financing, and may provide a starting point for future analysis. In addition, as discussed the automotive industry is undergoing a transformation, which will increase the future competitive pressure in the Electric Vehicle market. In this paper, a strategic analysis was conducted on how Tesla has disrupted the automotive industry and gained its competitive advantage. In future work, it thus would be interesting to see what strategies Tesla employs to sustain its competitive advantage.

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Appendix

Figure 1

Tesla´s Fleet

	Picture	**Description**	**Range in miles**	**Price in US$**
Tesla Roadster 2008		• Release 2008 • 2 doors • convertible coupe (removable hardtop)	244	109,000
Model S	 **s**	• Release 2012 • Four Door • 7 seater sport sedan	259-335	69,500-97,500
Model X		• Release 2015 • Four Door • SUV	200-325	80,000-144,000
Model 3		• Release 2018 • Four Door • Hatchback • Compact sedan	220-310	35,000-44,000

Model Y		• Release 2020 • 7 seated • midsize SUV • Hatchback	280- 330	39,000- 47,000
Cybertruck		• Not released yet • Six seats • Pickup Truck • Durable design	800	40,000- 70,000
Semi		• Not released yet • Cargo Truck	1000	130,000- 170,000
Tesla Roadster 2020		• Not Released yet • High class performance sports car	1000	200,000- 250,000

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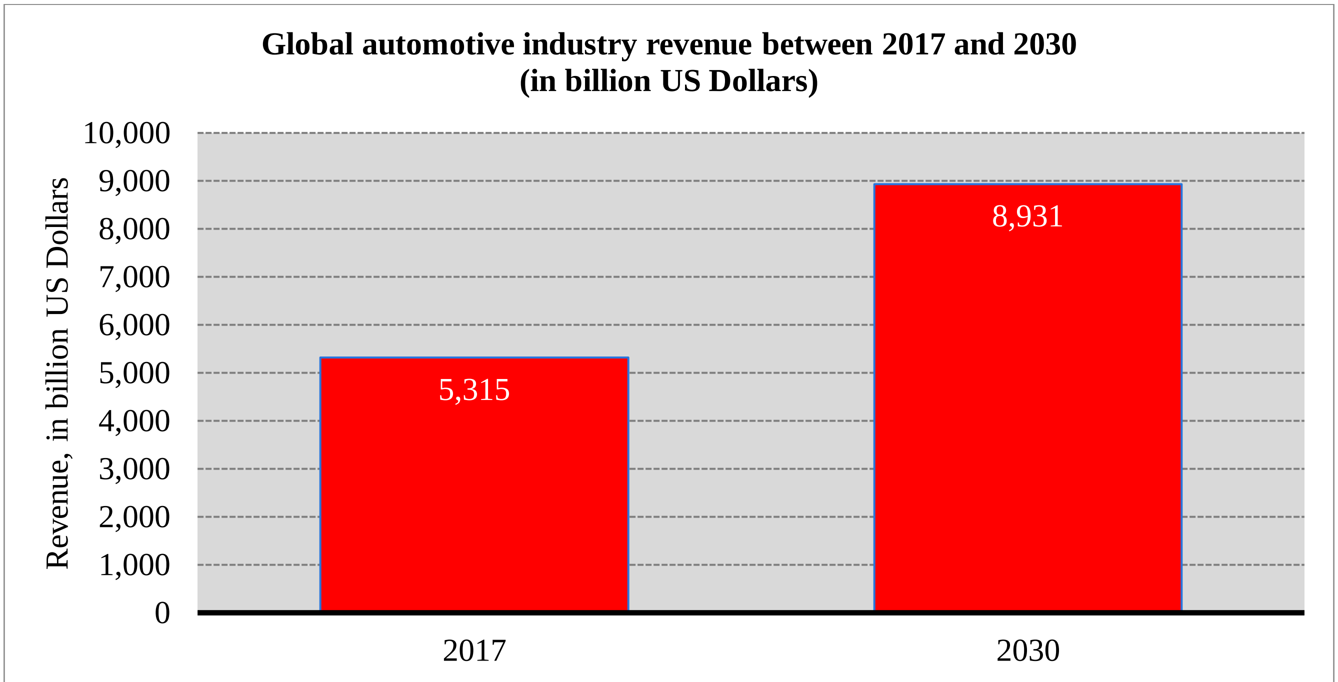
Figure 2



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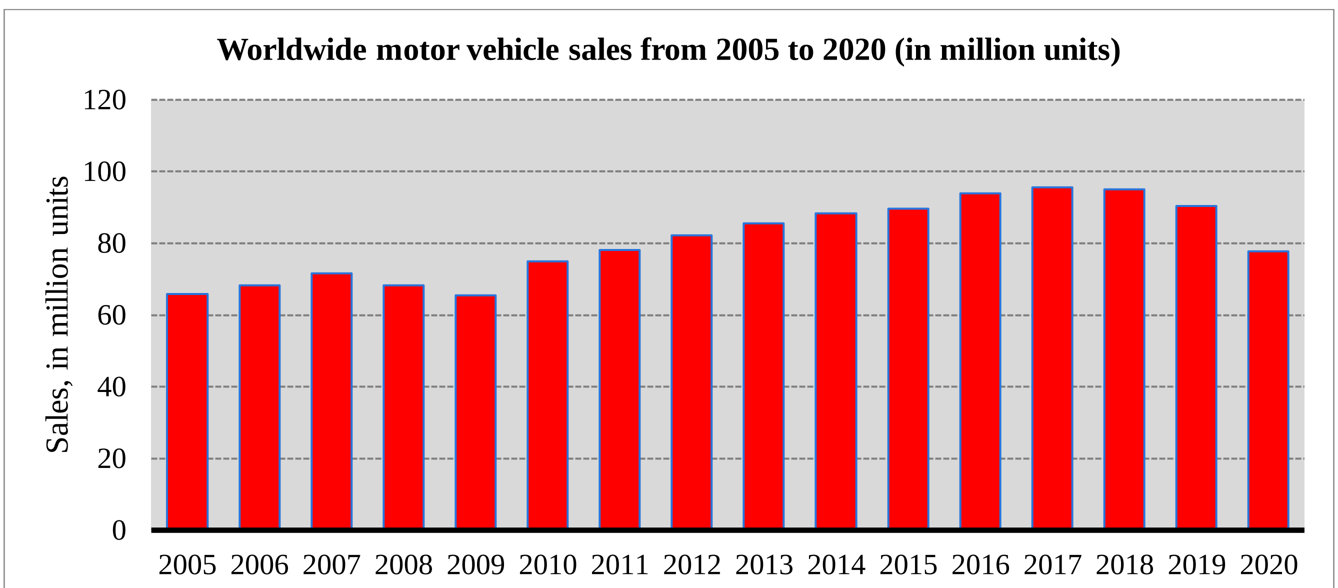
(Statista 2019d)

Figure 3



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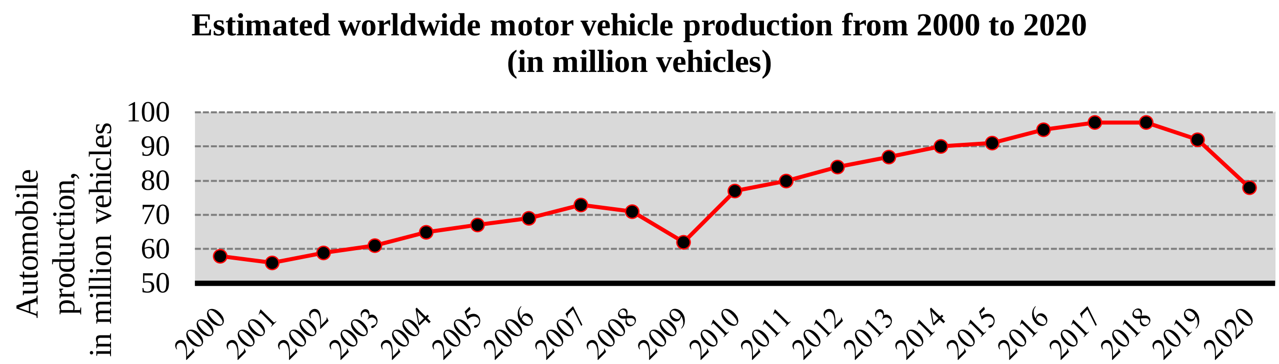
(Statista 2021h)

Figure 4 – Global production figures of produced vehicles



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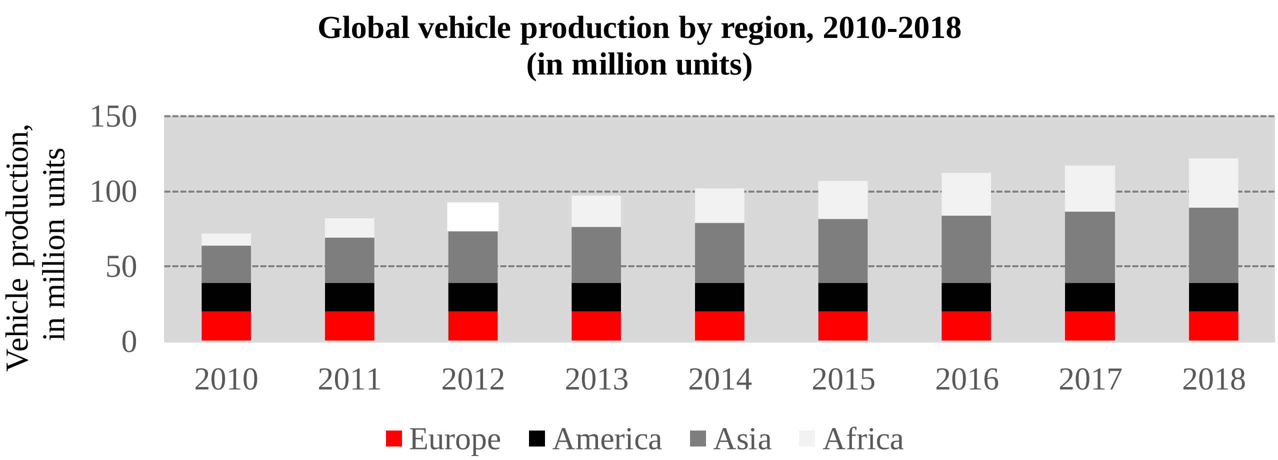

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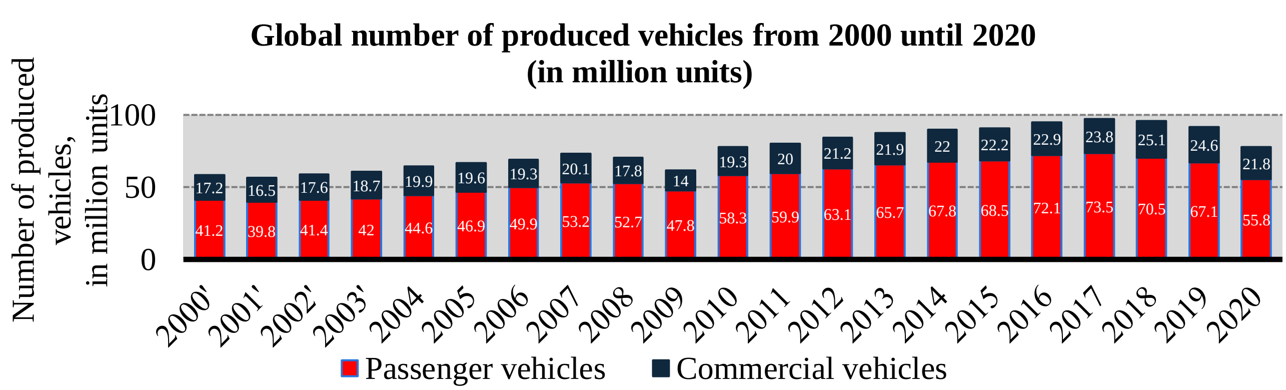

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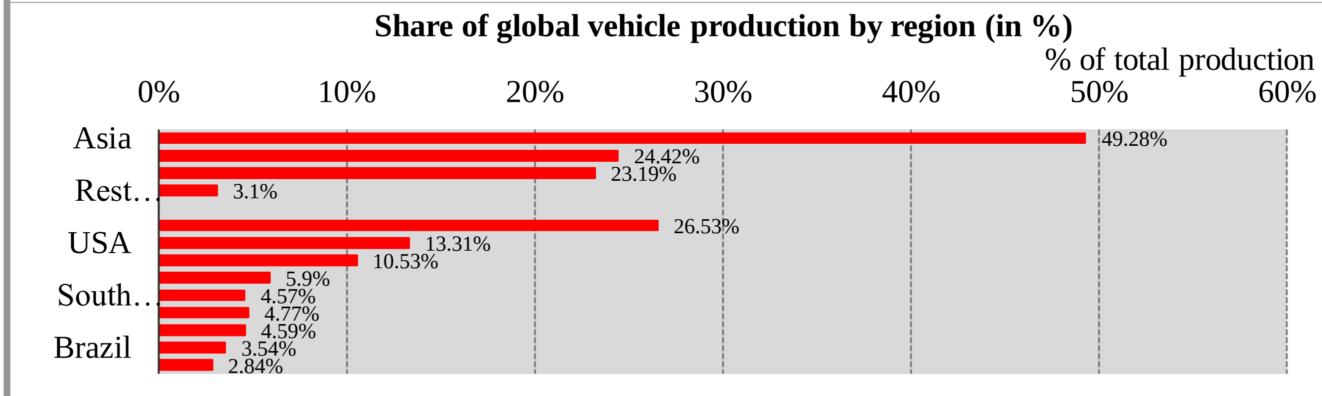

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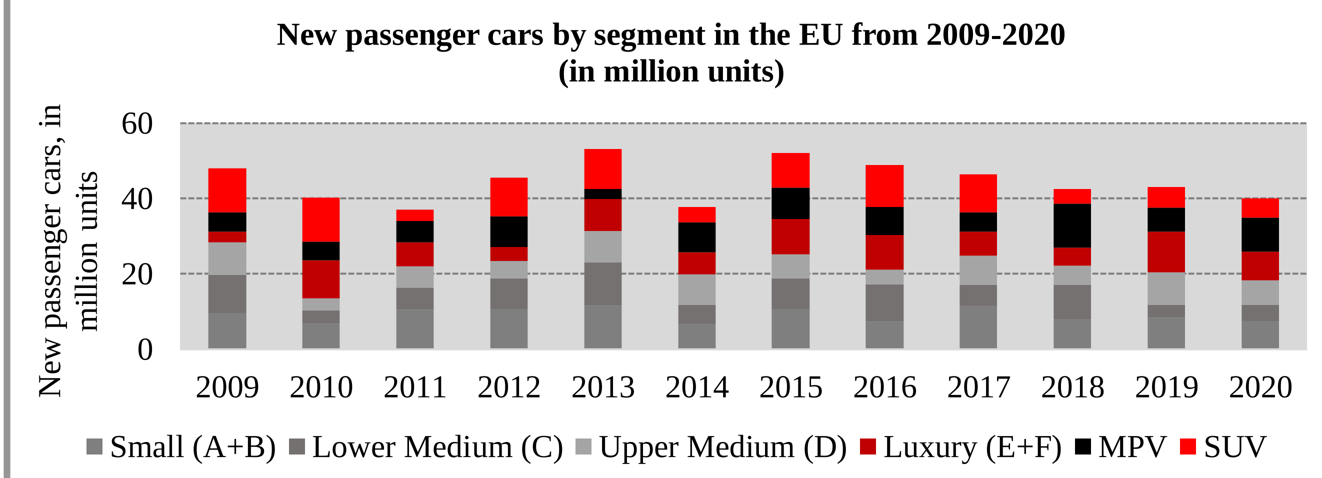

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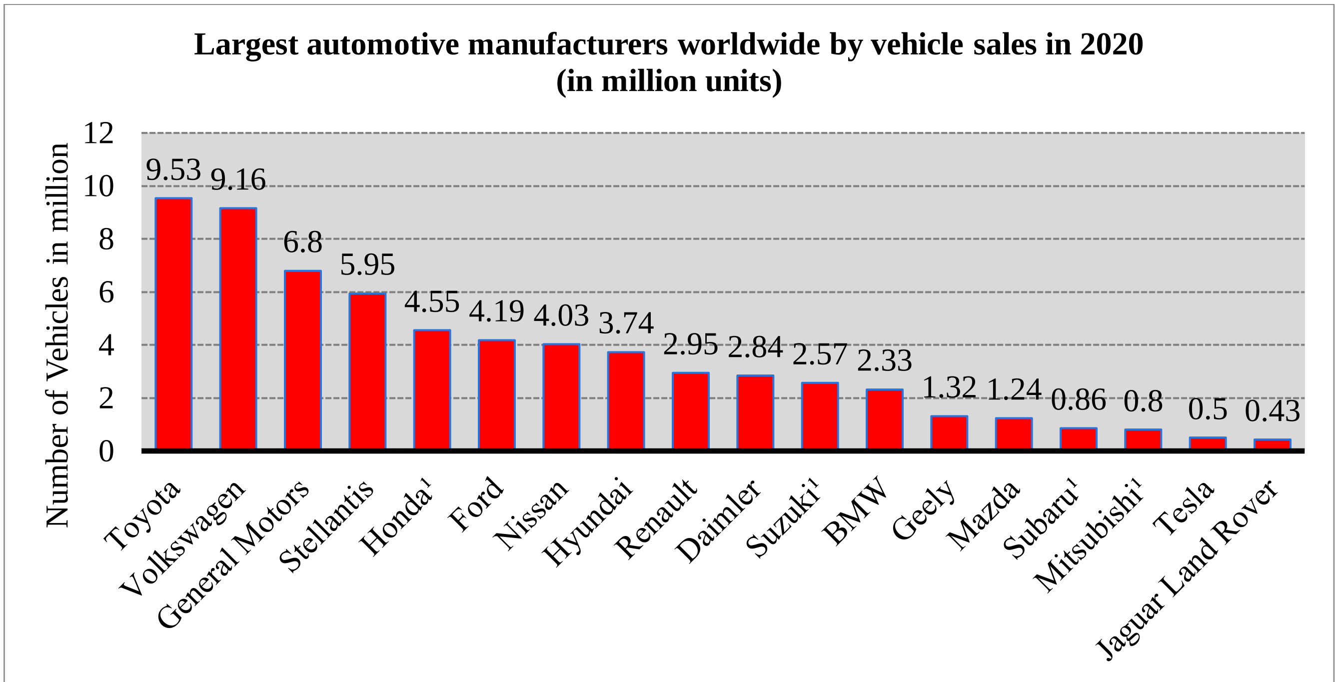
Figure 5



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(Statista 2021b)

Figure 6

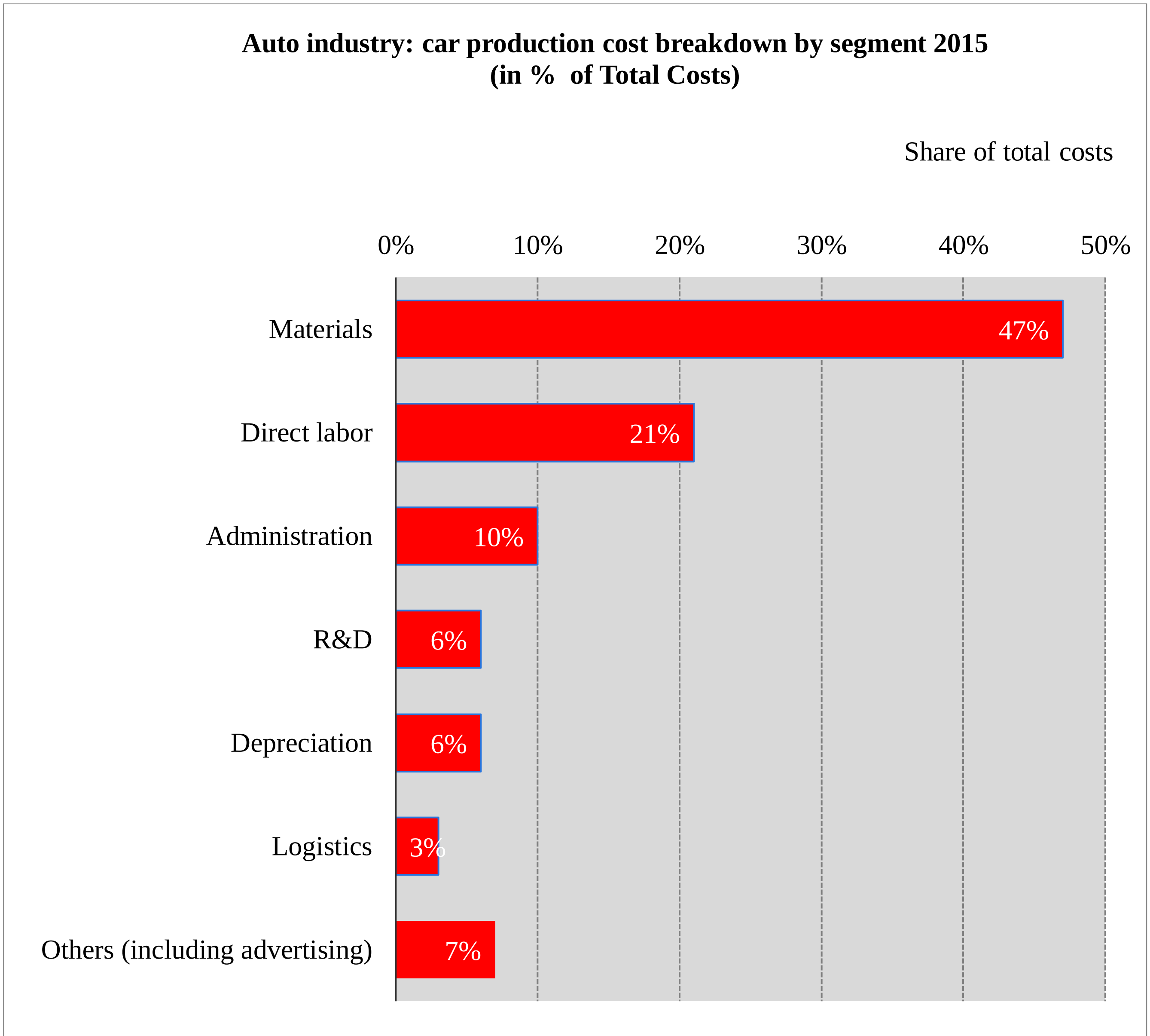

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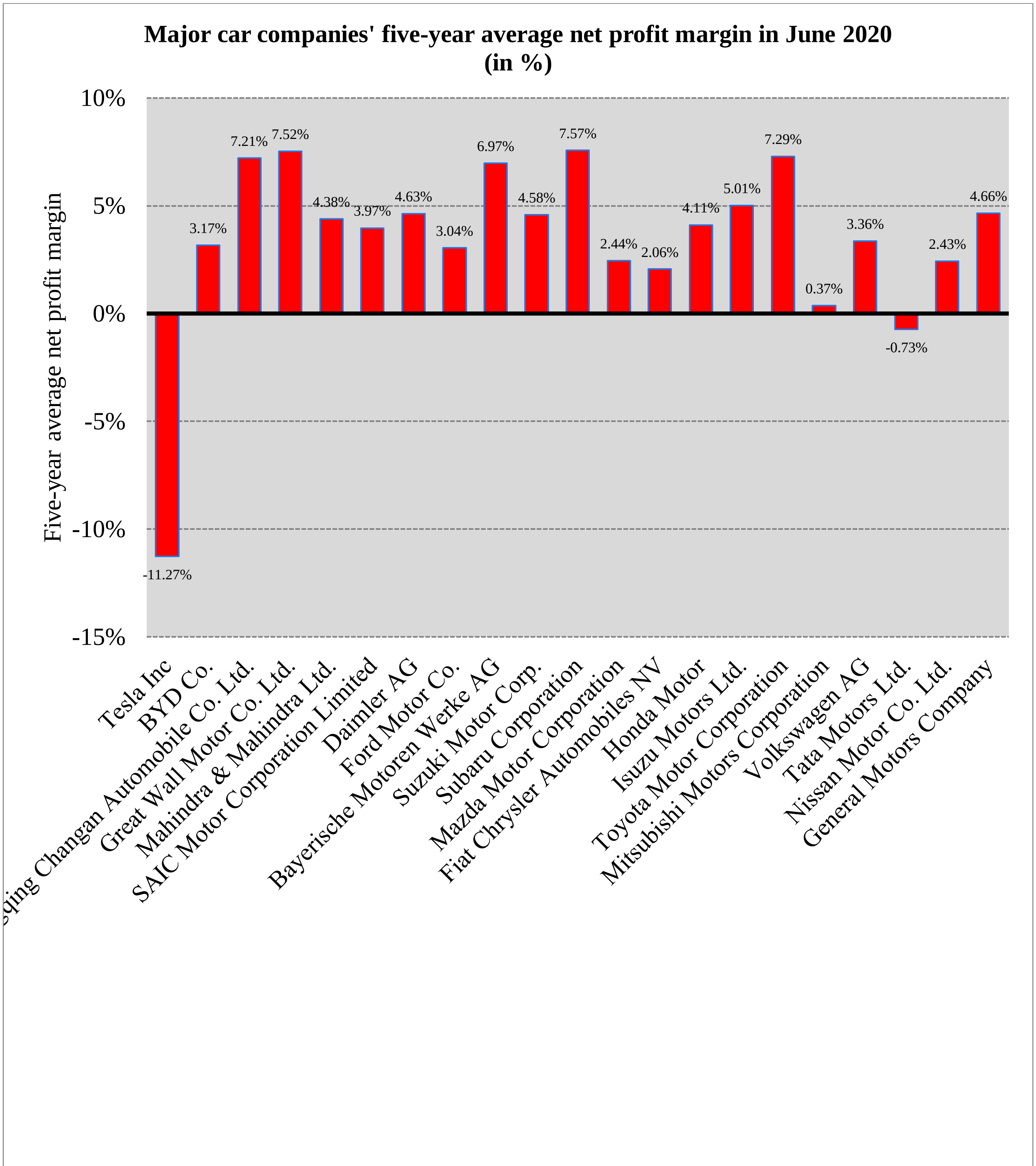
Figure 7



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(Statista 2020a)

Figure 8

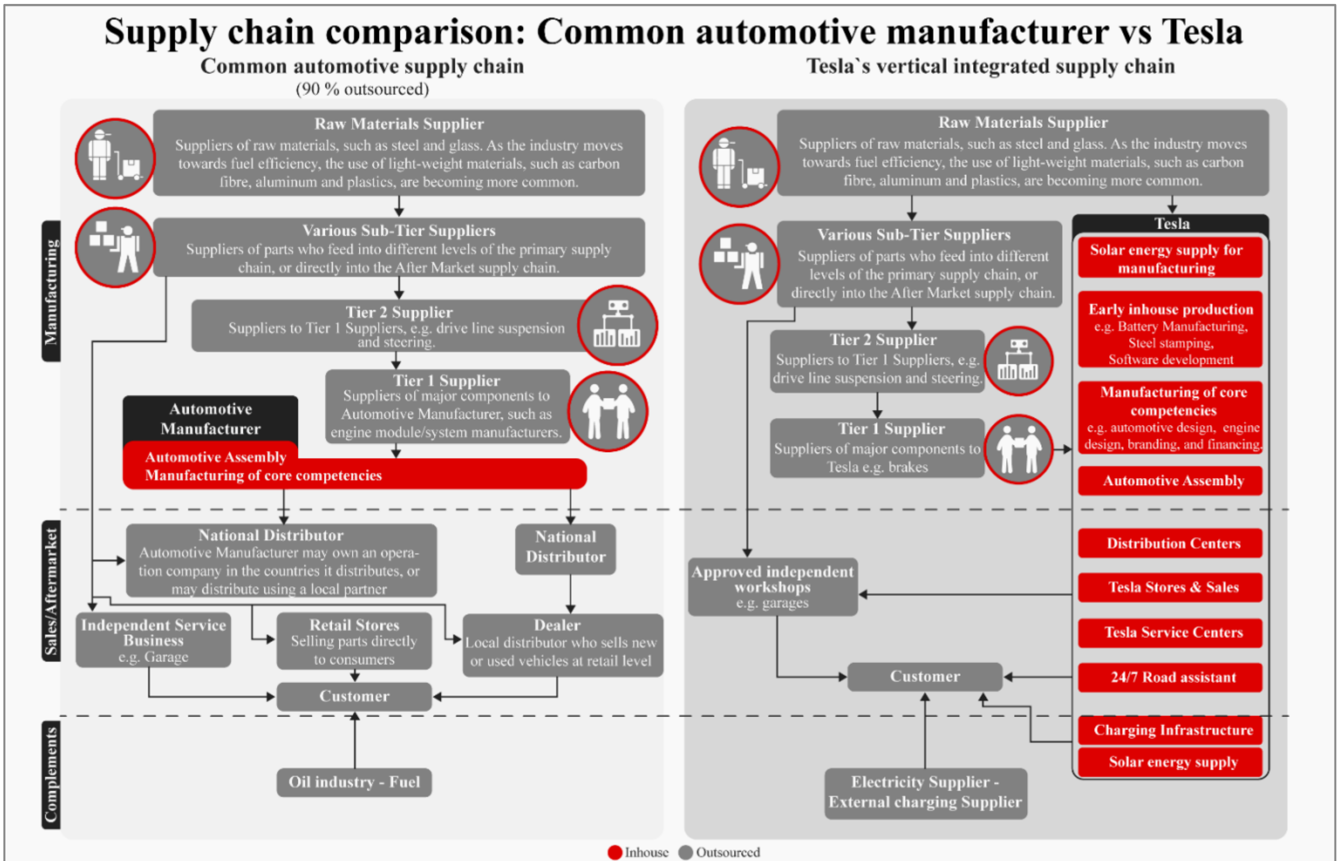

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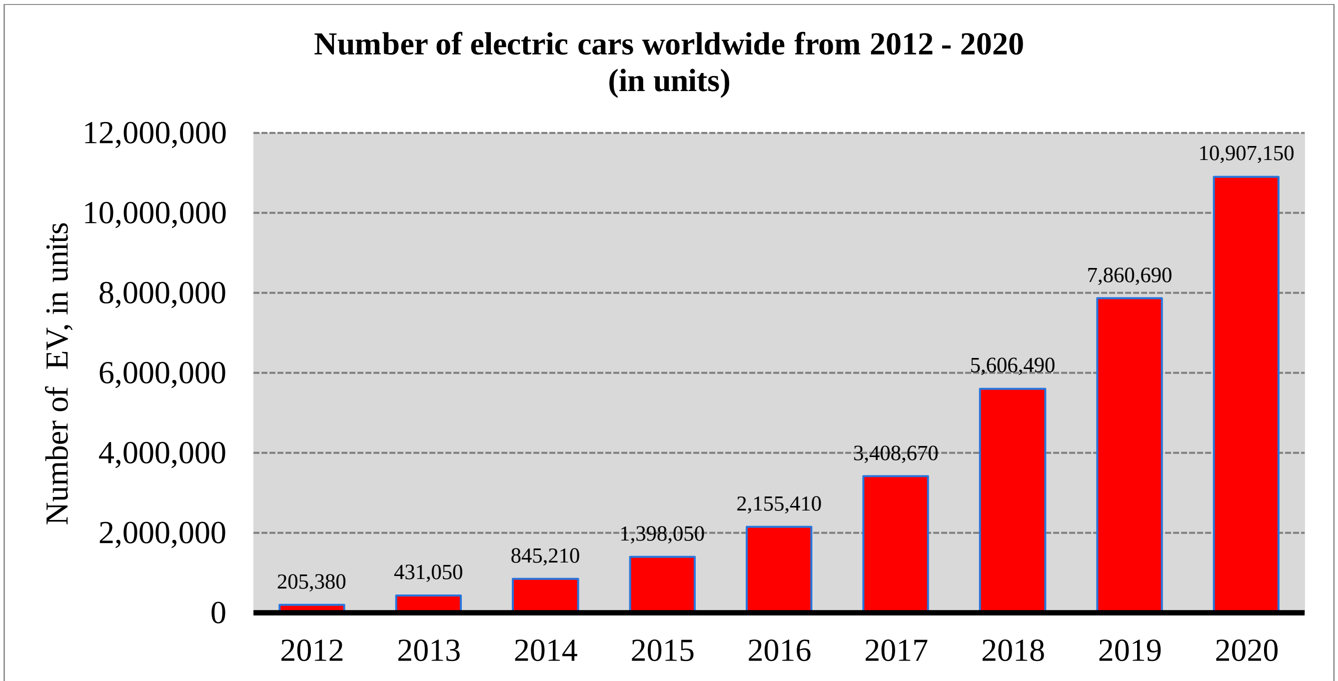
Figure 9



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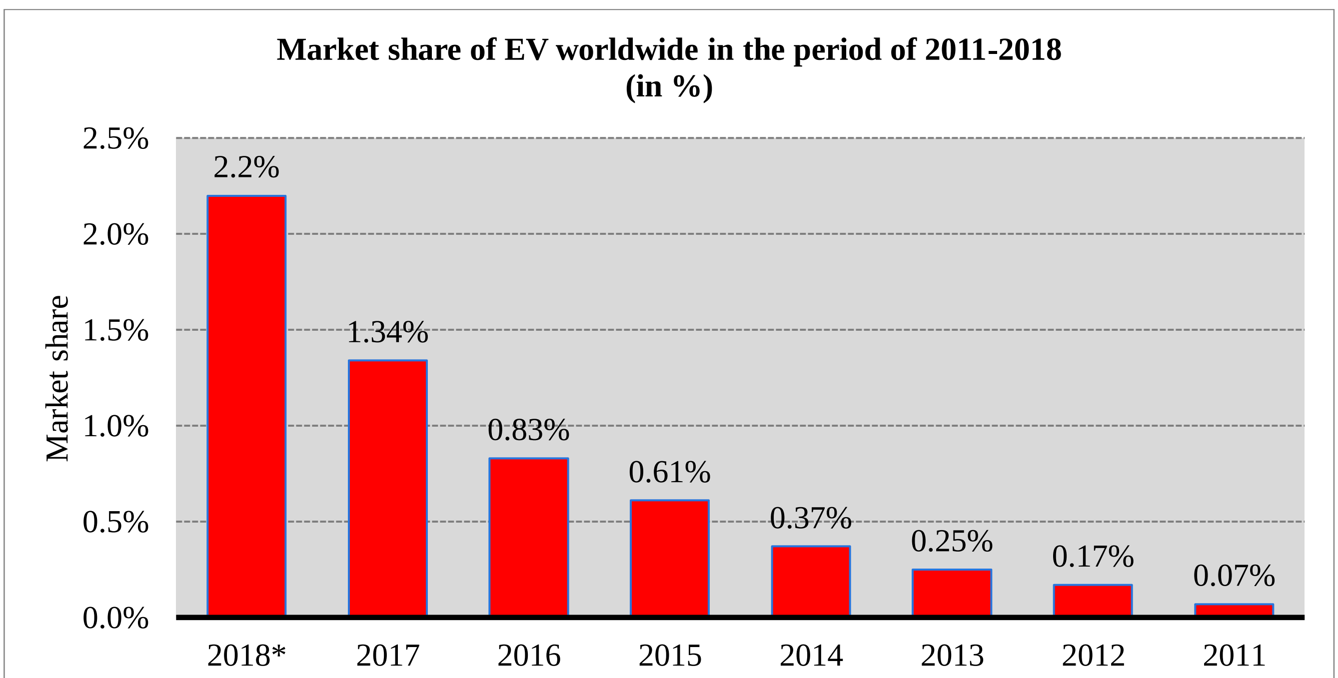
(Statista 2021a)

Figure 10



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(Statista 2019c)

Figure 11

Drive train components comparison ICE vs Battery EV

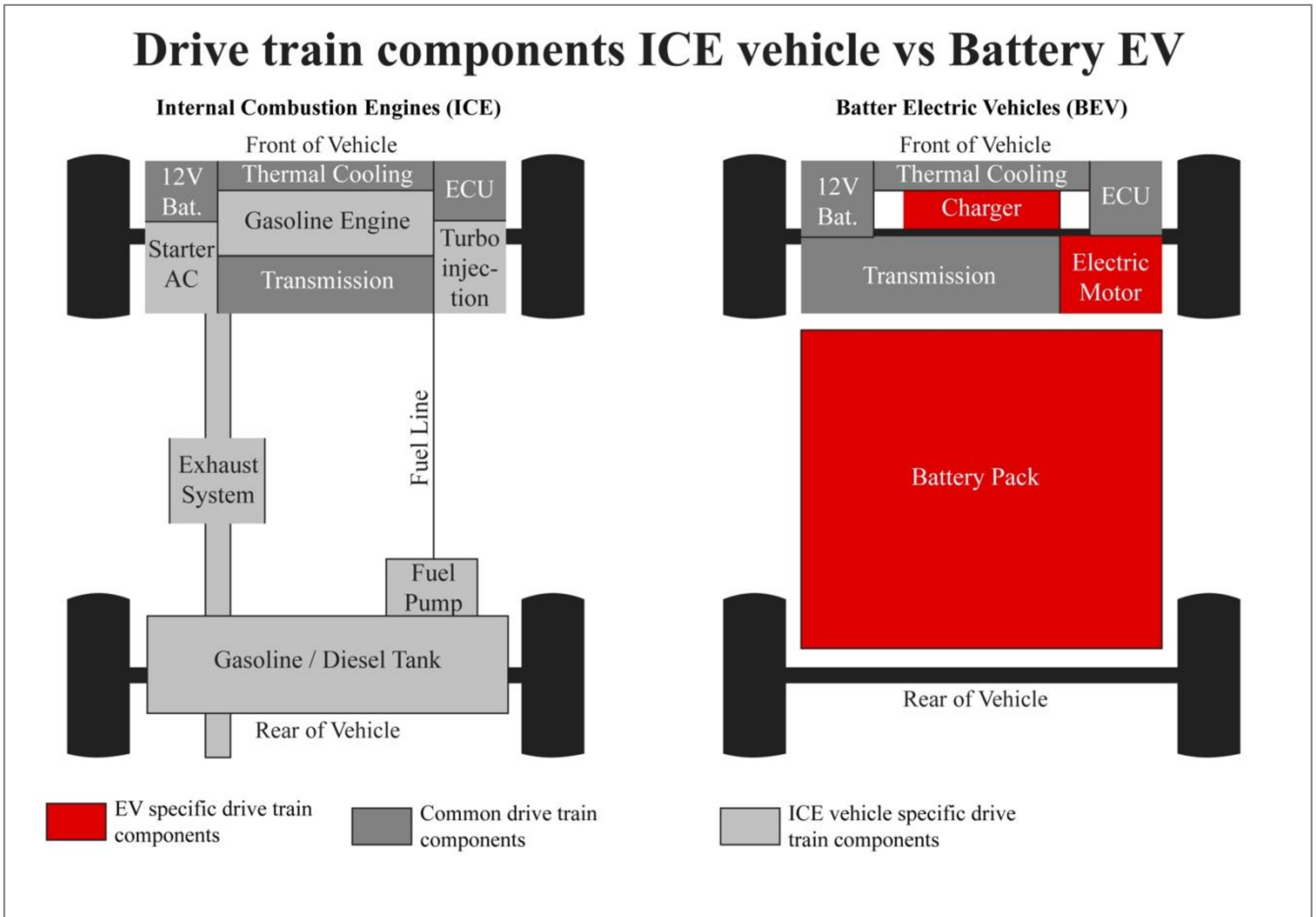

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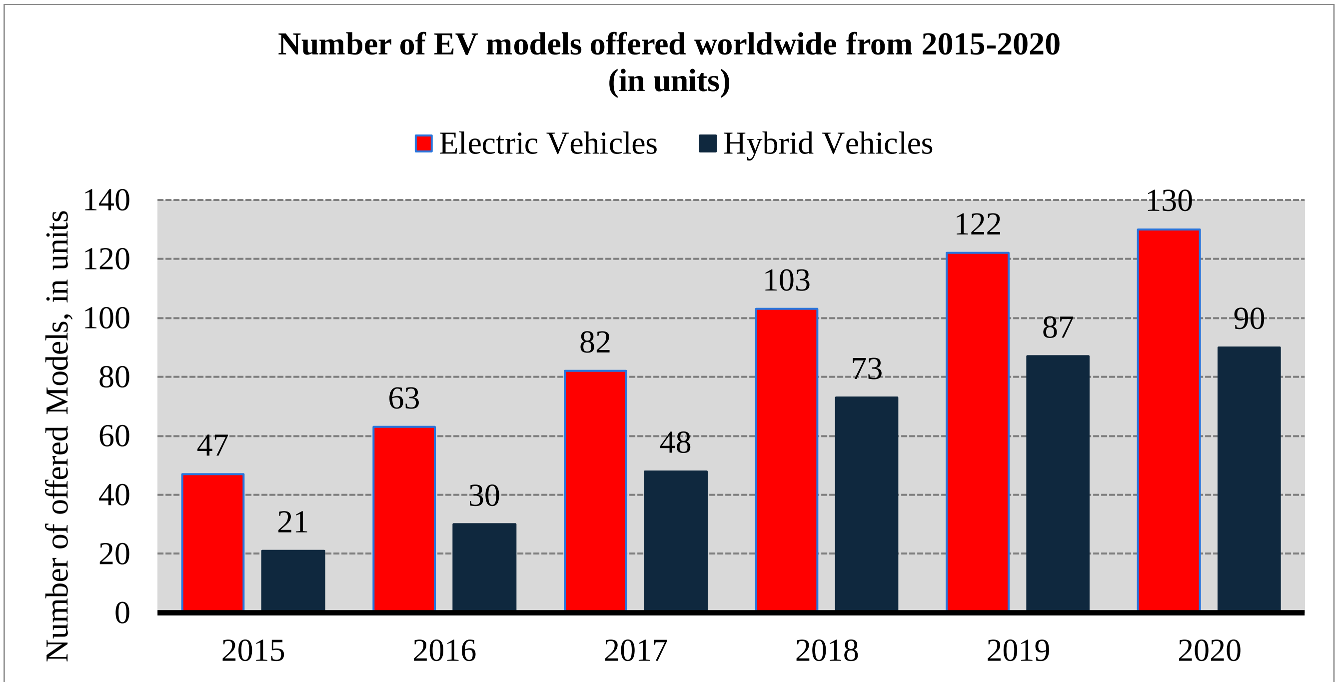
Figure 12



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(Statista 2019b)

Figure 13 – EV Model Comparison (Bohnsack and Pinkse 2017)

Brand	**Model**	**Year of Introduction**	**Price Starting from (in US$)**	**Electric Driving Range in km**
Reference Vehicle with ICE*- Ford	Ford Focus	2010	20,000	760
BMW	i3	2018	41,350	285
Nissan	Leaf	2010	28,980	200
Ford	Focus electric	2018	35,995	225
Renault	Zoe	2020	26,460	395
Fiat	500e	2020	31,800	321-460
Chevrolet	Spark EV	2013	26,685	130
Mercedes-Benz	B-Class Electric Drive	2014	42.375	140
Volkswagen	E-Golf	2014	35,445	230
Mitsubishi	i-MiEV	2011	22,995	160
Smart	For Two Electric Drive	2018	25,500	160
Volkswagen	e-Up	2020	34,500	260
Tesla	Roadster	2008	109,000	350
Tesla	Model 3	2016	35,000	560
Tesla	Model S	2012 (2020)	69,900	370-480, (610)

(Bohnsack and Pinkse 2017)

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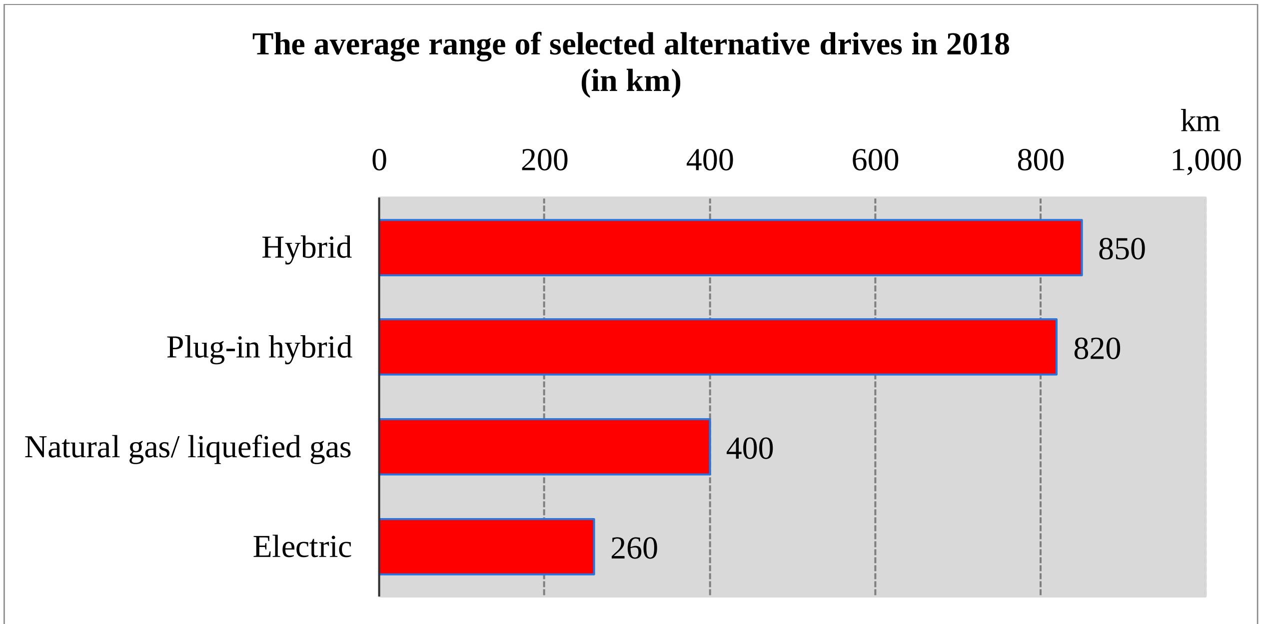
Figure 14



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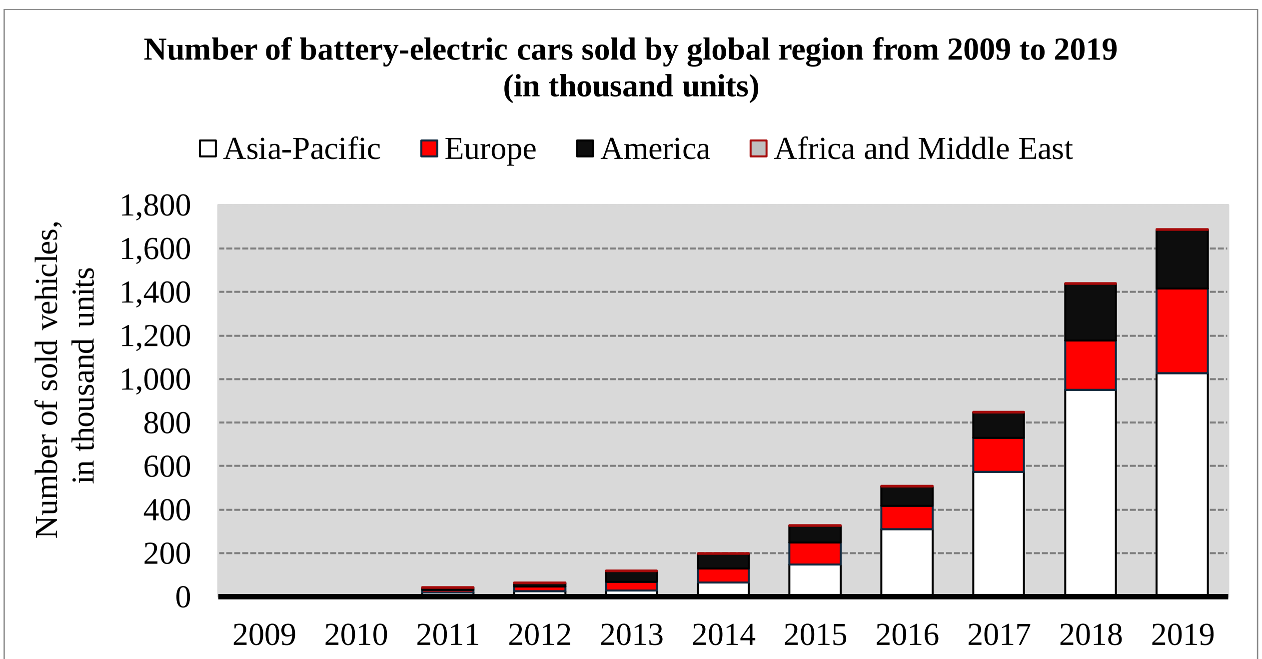
(Statista 2018)

Figure 15



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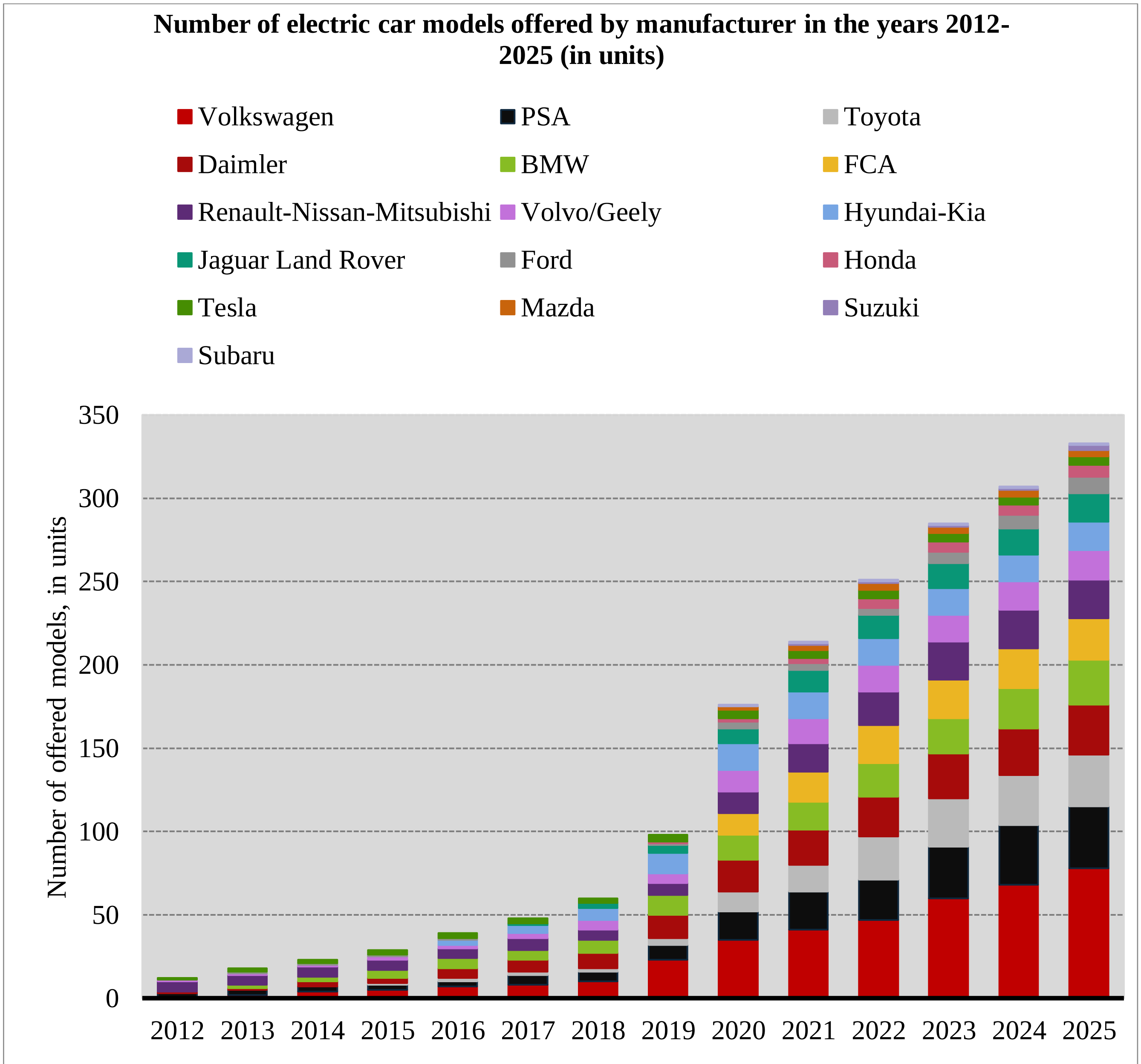
(Statista 2020b)

Figure 16



(Statista 2019a)

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Figure 17

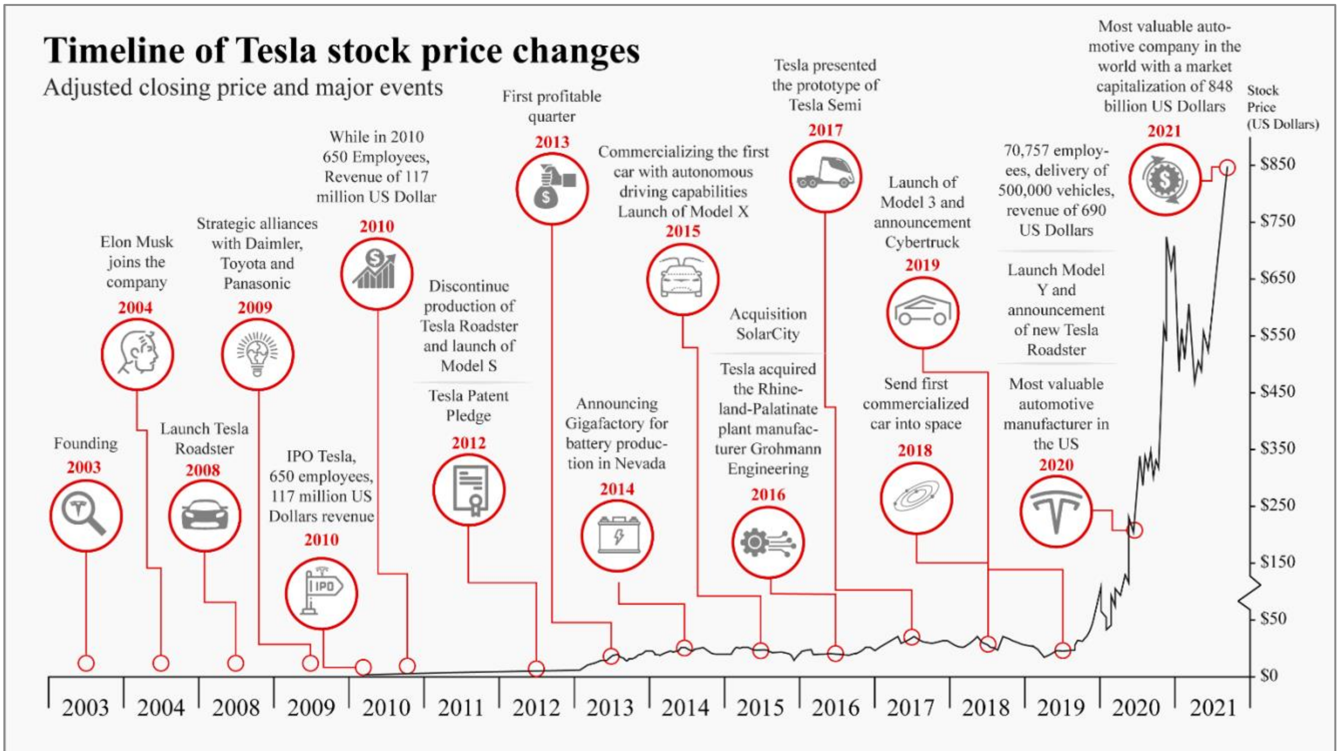

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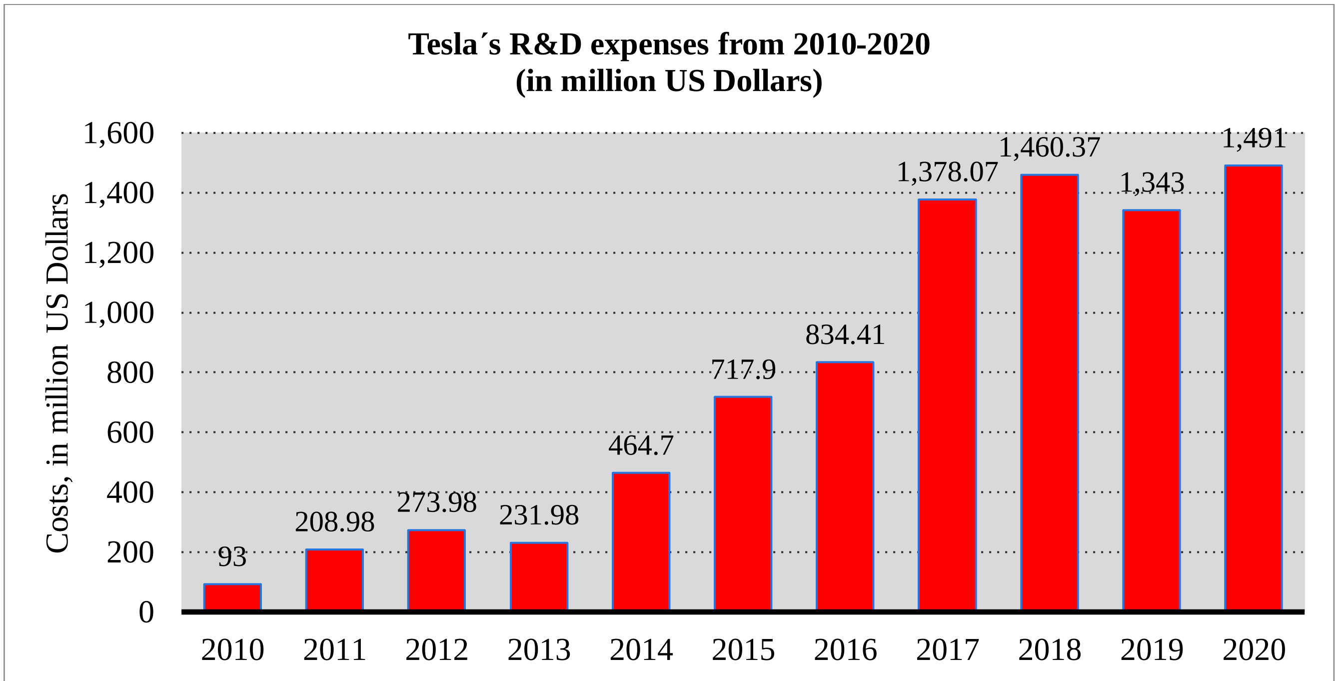
Figure 18

Excurse - Elon Musk

Picture	
Name	Elon Reeve Musk
Birthdate / Place	27.06.1971 / Pretoria, South Africa
Companies	Zip2, 1995(software company); PayPal, 2000 (online payment system); SpaceX, 2002 (Space Transport); Tesla Motors, 2003 (EV- Automotive), SolarCity, 2006 (Solar energy systems); OpenAI, 2015 (Artificial Intelligence research), Neuralink, 2016 (neurotechnology), The Boring Company, 2017 (tunnel construction /infrastructure)
Biography	Elon Musk was born in Pretoria, South Africa, in 1971. At the age of 17, Musk moved to Kingston, Canada, to begin his bachelor's degree in physics and complete it alongside a bachelor's degree in economics at the University of Pennsylvania and Wharton Business School, USA. In 1995, he decided to move to Silicon Valley, California, to start an Internet start-up. In the same year, Elon Musk founded the Internet start-up Zip2 with his brother. This company was sold to computer manufacturer Compaq in 1999 for $307 million. Musk then founded X.com, an online payment system,

Back to page 7	and merged it with Confinity. Now called PayPal, it was sold to eBay in 2002 for $1.56 billion. PayPal revolutionized the online financial system. In 2002, he took a new approach to offering technically complex products at low cost and to the mass market. In the same year he founded SpaceX and became a major investor in Tesla Motors in 2003. Space X should have the aim to Commerciale space flights and to colonize mars, and revolutionized the rocket industry. On the Other hand Tesla Motors pushed the focus on EV back into the market. Further He also participated in his cousin's company SolarCity as a major investor in 2006, which offered sustainable solar energy system solutions. With the 2008 financial crisis, his companies Tesla Motors and SpaceX were on the brink of ruin, but were able to survive. In 2013, Musk introduced the idea of the Hyperloop, a high-speed mass transportation system between cities, which could have the potential to revolutionize the travel industry. In 2015, Musk and 5 other founders created OpenAI, a company dedicated to artificial intelligence research. In 2016, Elon Musk and 8 other partners founded Neuralink Corporation, which deals with implantable brain-machine interfaces, with the aim to connect the Human Brain to computers. Due to his personal conflict with the Los Angles traffic system and the constant traffic jams, he announced the idea of to take the traffic system underground. For that matter he founded “The Boring Company” to enhance the Tunnel systems. Elon Musk is not only perceived as one of the greatest pioneers and visionaries of our time, but also became the richest man in the world in 2020. (Gregersen 2021)

Figure 19



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(Statista 2021e)

Figure 20

Model	**0-60 mph**	**¼ mile**
Tesla Model S Plaid	<2.0 sec	<9.3 sec
Porsche 918 Spyder	2.1 sec	9.7 sec
Porsche 911 Turbo S (992)	2.2 sec	10.1 sec
Lamborghini Huricán Performante	2.2 sec	10.2 sec
Tesla Model S Performance	2.3 sec	10.4 sec
Dodge Challenger SRT Demn	2.3 sec	10.7 sec
Bugatti Chiron	2.4 sec	9.4 sec
Porsche Taycan Turbo S	2.4 sec	10.3 sec
Nissan GT-R Nismo	2.5 sec	10.8 sec
Bugatti Veyron	2.5 sec	9.9 sec

(Tesla 2021b)

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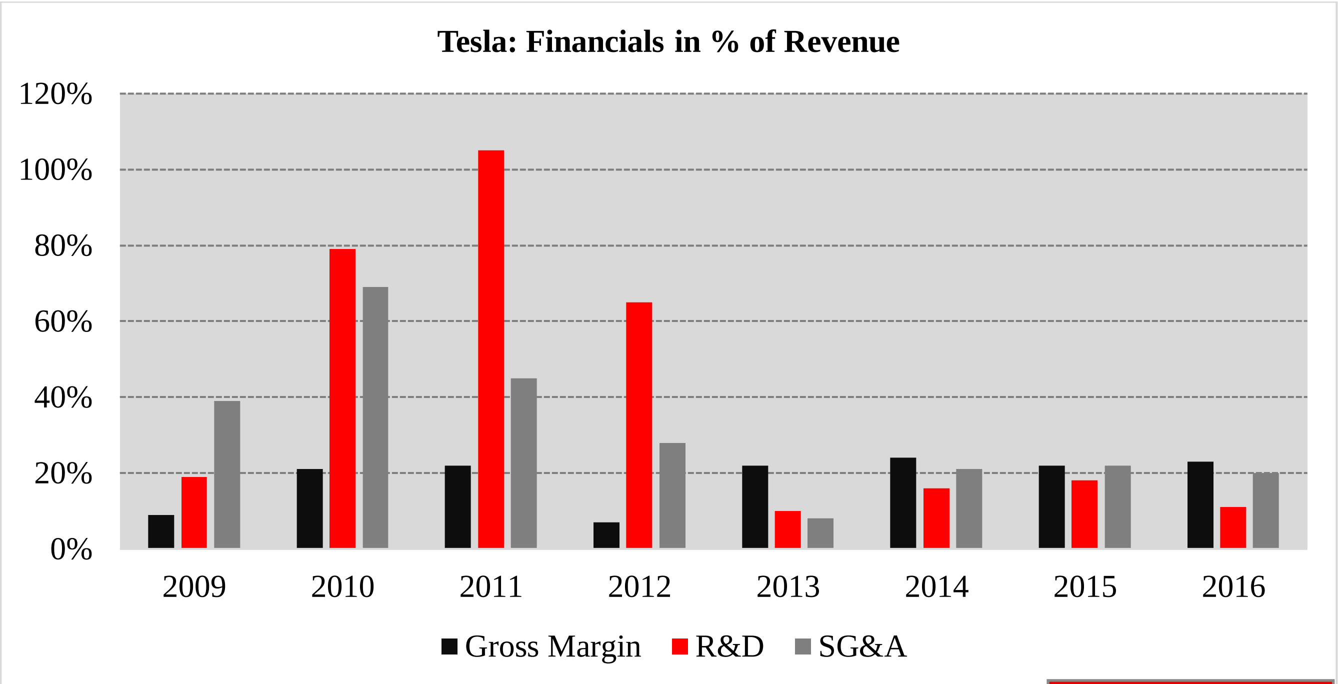
Figure 21



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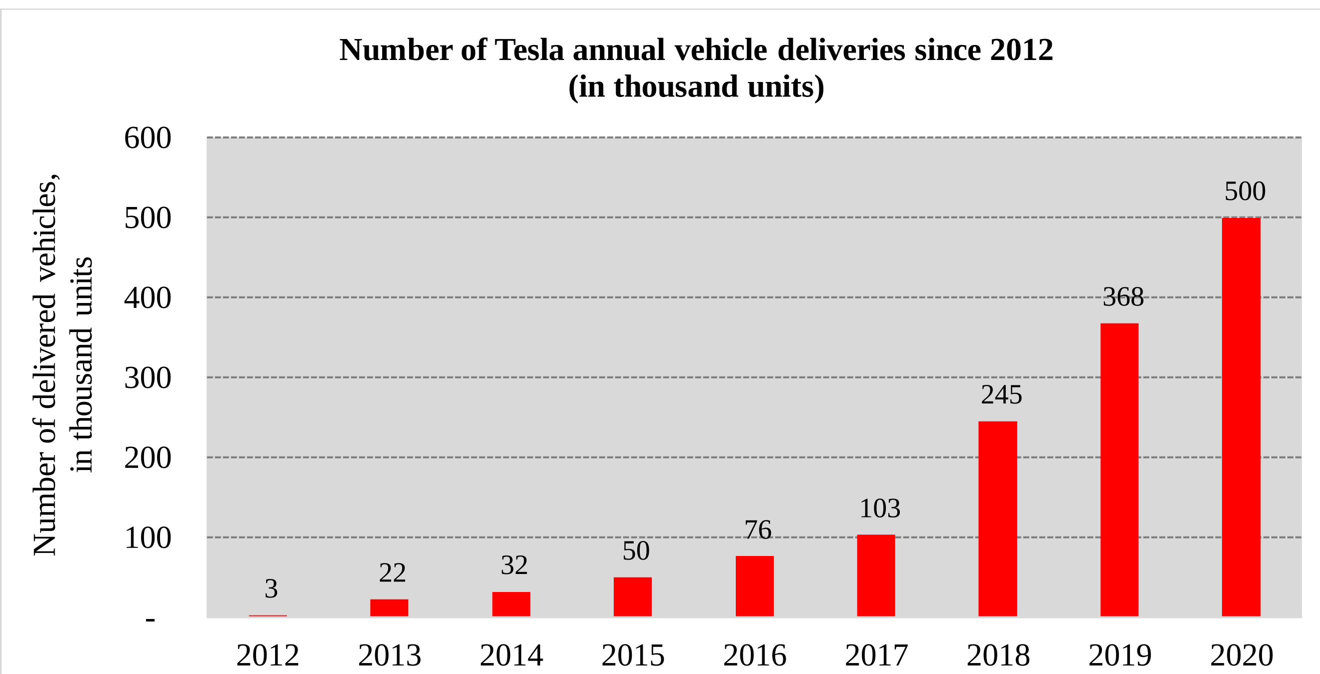
(Statista 2021e)

Figure 22



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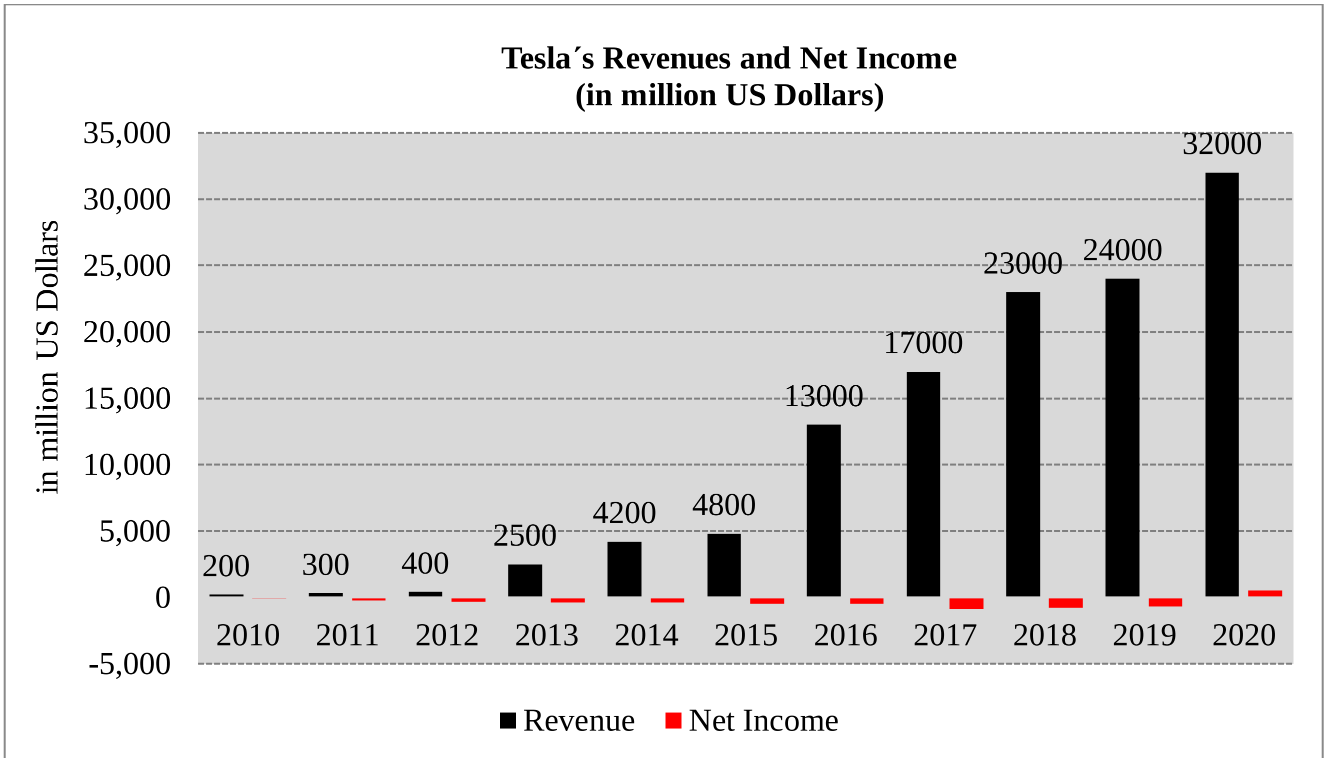
(Statista 2021c)

Figure 23



(Statista 2021f)

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Figure 24

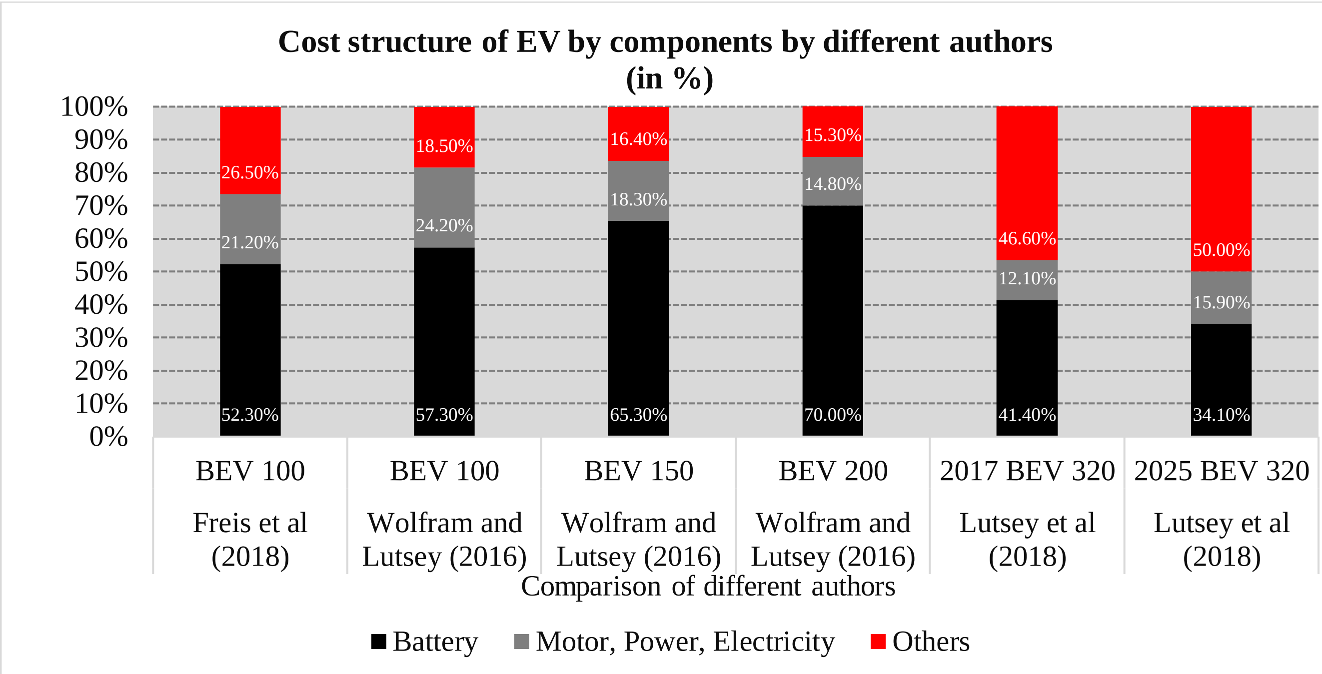

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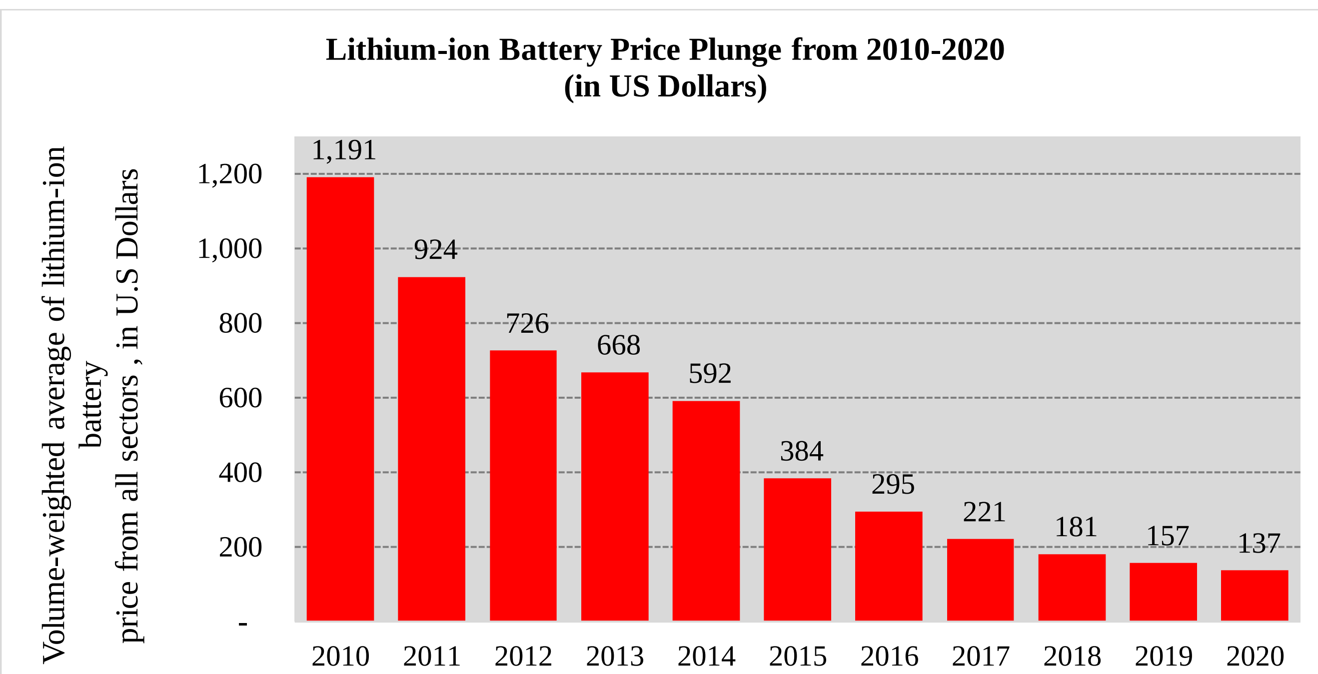
Figure 25



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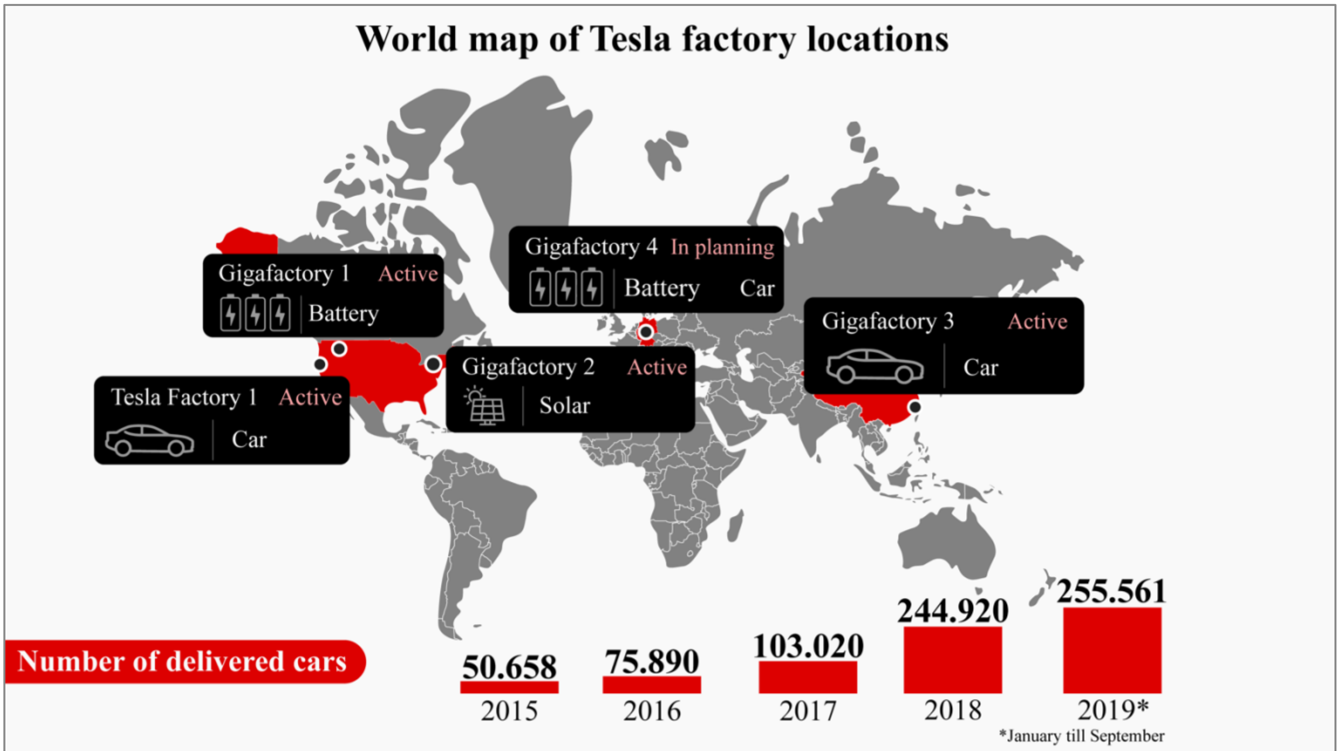
(Statista 2020c)

Figure 26



(Statista 2019e)

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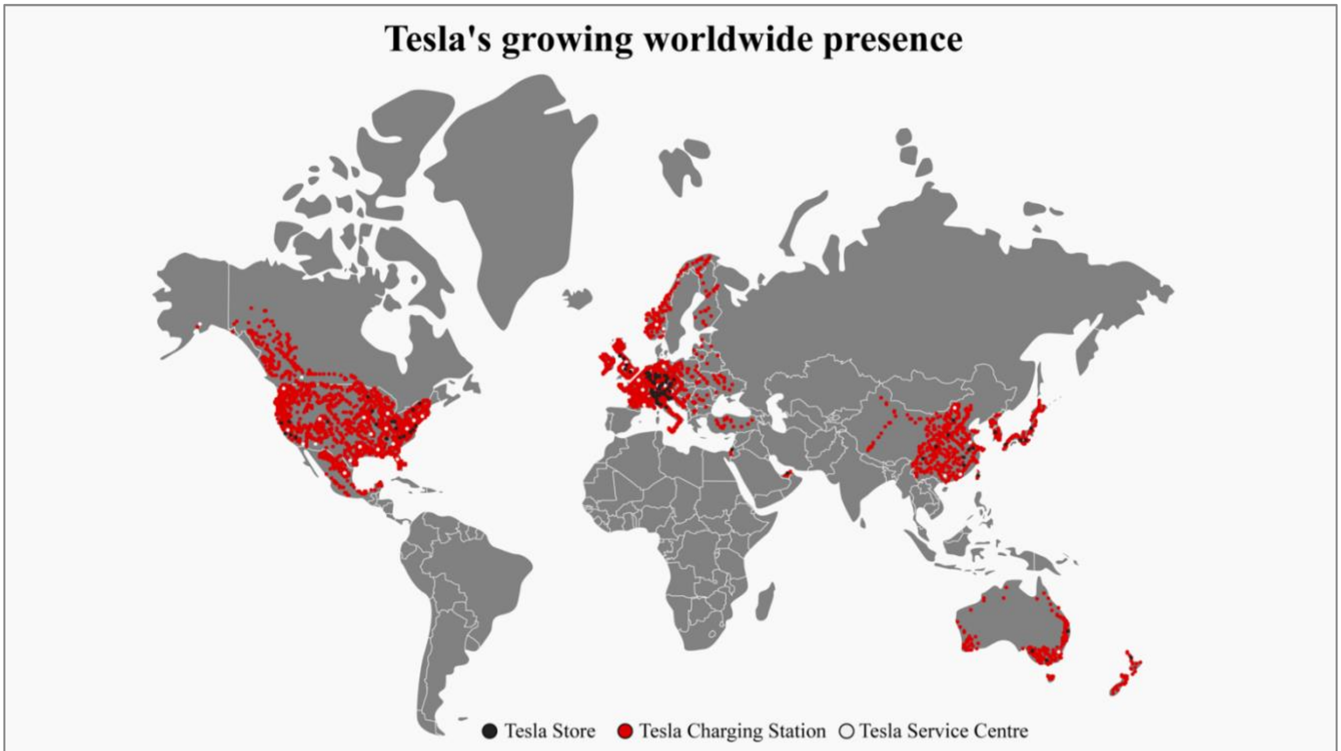
Figure 27



(Fruhlinger 2019)

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Figure 28

Picture of Tesla Store in Madrid, Spain

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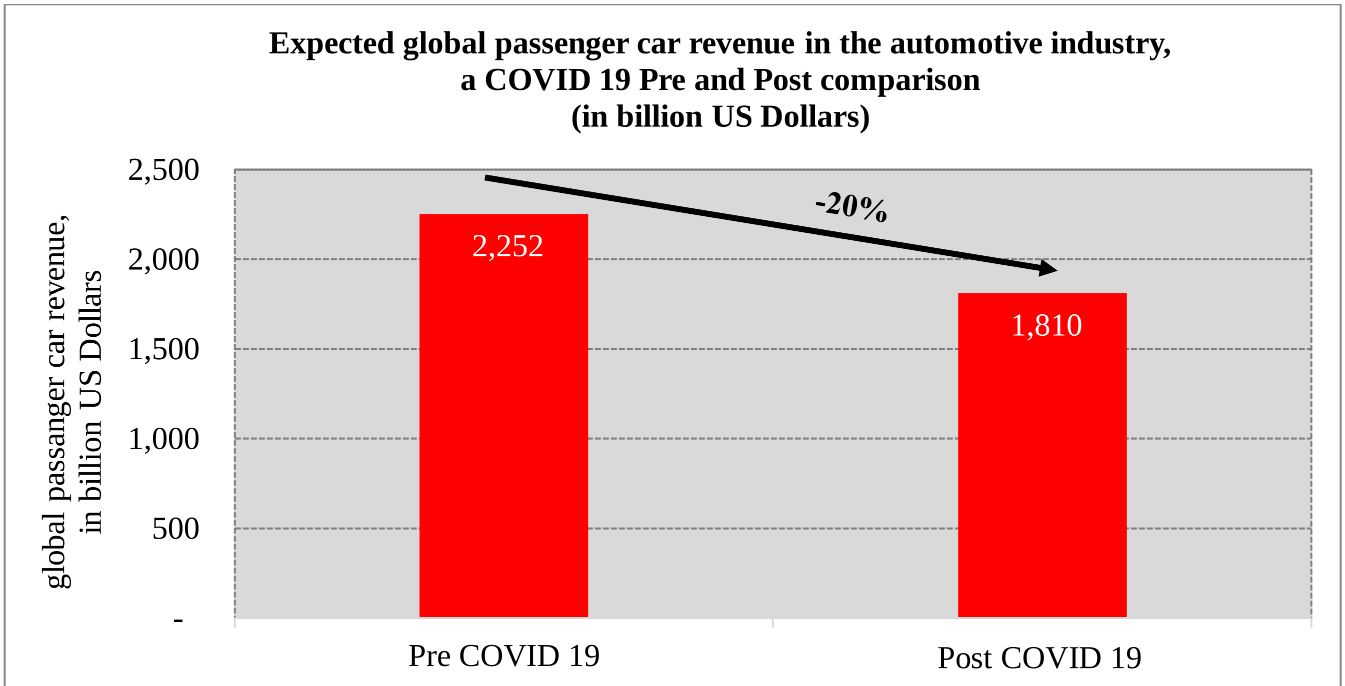
(Wardsauto 2017)

Figure 29



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(Ahlswede, Oloruntoba, and Andrades Sanchez 2020)

Figure 30

Taxonomy of Disruptive Innovation

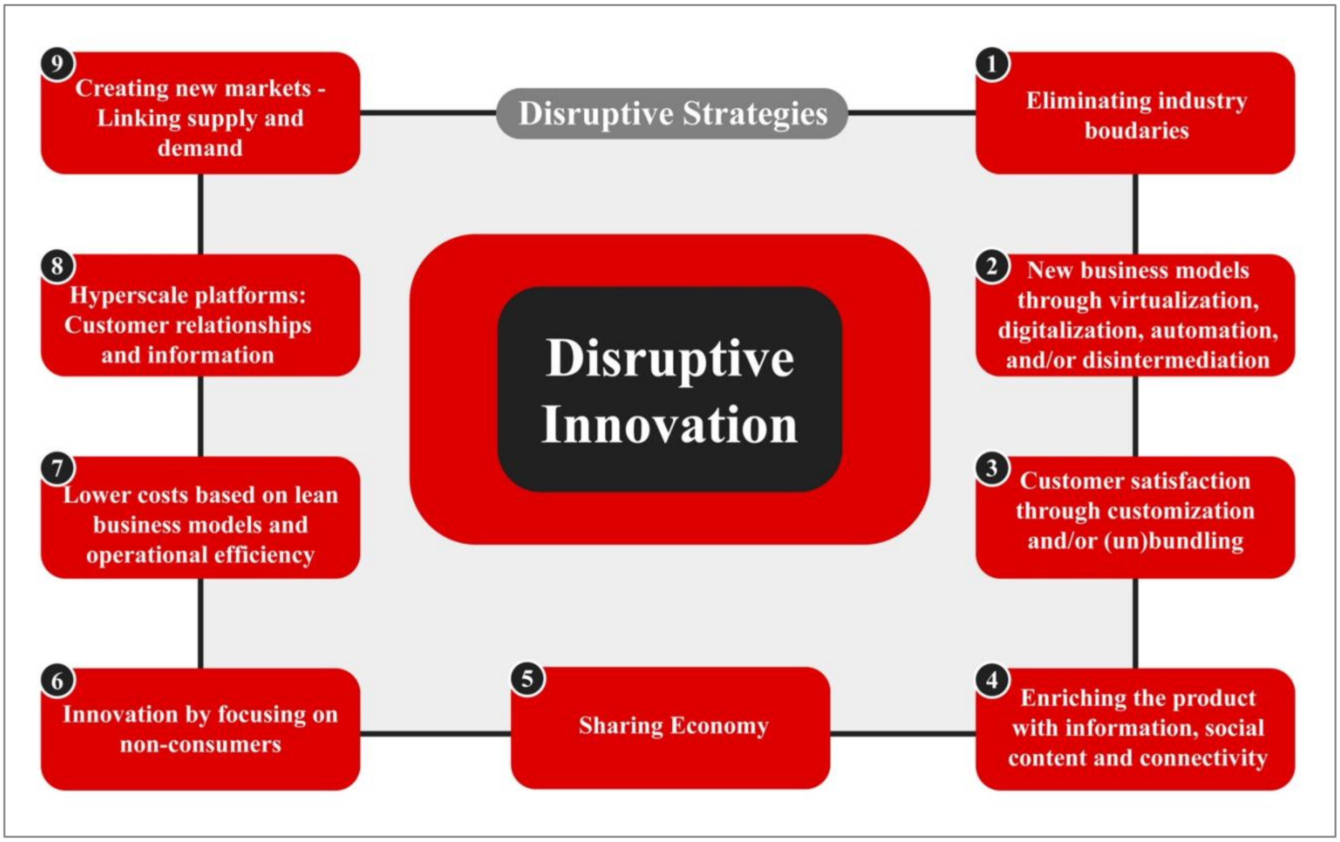

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Figure 31

Research Papers for Taxonomy

1	Christensen, Clayton M., Heiner Baumann, Rudy Ruggles, and Thomas M. Sadtler. 2006. "Disruptive Innovation for Social Change." Harvard Business Review, December 1, 2006. https://hbr.org/2006/12/disruptive-innovation-for-social-change. (Christensen et al. 2006)
2	Charitou, C. D., & Markides, C. C. (2003). Responses to disruptive strategic innovation. MIT Sloan Management Review, 44(2), 55-63A.
3	Schmidt, G., & van der Rhee, B. (2014). How to position your innovation in the marketplace. MIT Sloan Management Review, 55(2), 17.3f
4	Christensen, Clayton M., Heiner Baumann, Rudy Ruggles, and Thomas M. Sadtler. 2006. "Disruptive Innovation for Social Change." Harvard Business Review, December 1, 2006. https://hbr.org/2006/12/disruptive-innovation-for-social-change. (Christensen et al. 2006)
5	Roy, Raja, and Susan K. Cohen. 2017. "Stock of Downstream Complementary Assets as a Catalyst for Product Innovation during Technological Change in the US Machine Tool Industry." Strategic Management Journal 38 (6): 1253–67. https://doi.org/10.1002/smj.2557. (Roy and Cohen 2017)
6	Dr. Fleig, Jürgen. 2020. "Innovationen 3 Beispiele Für Eine Disruptive Innovation." Business-Wissen.de, May 25, 2020. https://www.business-wissen.de/artikel/innovationen-3-beispiele-fuer-eine-disruptive-innovation/. (Dr. Fleig 2020)
7	O'Reilly, Charles, and Andrew J. M. Binns. 2019. "The Three Stages of Disruptive Innovation: Idea Generation, Incubation, and Scaling." California Management Review 61 (3): 49–71. https://doi.org/10.1177/0008125619841878. (O'Reilly and Binns 2019)

8	Adner, Ron. 2002. "When Are Technologies Disruptive? A Demand-Based View of the Emergence of Competition." Strategic Management Journal 23 (8): 667–88. https://doi.org/10.1002/smj.246. (Adner 2002)
9	Moreau, Francois. 2012. "The Disruptive Nature of Digitization: The Case of the Recorded Music Industry." International Journal of Arts Management 15 (2): 18–31. (Moreau 2012)
10	Christensen, Clayton M., Michael E. Raynor, and Rory McDonald. 2015. "What Is Disruptive Innovation?" Harvard Business Review December 2015 (December): 5. (Christensen, Raynor, and McDonald 2015)
11	Bohnsack, R., & Pinkse, J. (2017). Value propositions for disruptive technologies: Reconfiguration tactics in the case of EV. California Management Review, 59(4), 79-96.
12	Hwang, J., & Christensen, C. M. (2008). Disruptive innovation in health care delivery: a framework for business-model innovation. Health affairs, 27(5), 1329-1335.
13	Rao, T. U. An Analysis of Disruptive Innovation with IBM developed PC along with iPod & iPhone of Apple Inc.
14	Corsi, S. & Di Minin, A. (2013). Disruptive Innovation. in Reverse: Adding a Geographical Dimension to Disruptive Innovation Theory. Creativity and Innovation Management, 23(1), 76–90. https://doi.org/10.1111/caim.12043
15	Markides, C. (2006). Disruptive innovation: In need of better theory. Journal of product innovation management, 23(1), 19-25.
16	Van Alstyne, M. W., Parker, G. G., & Choudary, S. P. (2016). Pipelines, platforms, and the new rules of strategy. Harvard business review, 94(4), 54-62.
17	Fox, J. (2014). How to succeed in business by bundling–and unbundling. Harvard Business Review, 24.

18	Khatab, Ziyad, and George M. Yousef. 2021. "Disruptive Innovations in the Clinical Laboratory: Catching the Wave of Precision Diagnostics." Critical Reviews in Clinical Laboratory Sciences, July, 1–17. https://doi.org/10.1080/10408363.2021.1943302.
19	Ozalp, Hakan, Carmelo Cennamo, and Annabelle Gawer. 2018. "Disruption in Platform-Based Ecosystems." Journal of Management Studies 55 (7): 1203–41. https://doi.org/10.1111/joms.12351.
20	Urbinati, Andrea, Davide Chiaroni, Vittorio Chiesa, Simone Franzò, and Federico Frattini. 2018. "An Exploratory Analysis on the Contextual Factors That Influence Disruptive Innovation: The Case of Uber." International Journal of Innovation and Technology Management 15 (03): 1850024. https://doi.org/10.1142/S0219877018500244
21	Rakic, Kristina. 2020. "Breakthrough and Disruptive Innovation: A Theoretical Reflection." Journal of Technology Management & Innovation 15 (4): 93–104. https://doi.org/10.4067/S0718-27242020000400093.
22	Agnihotri, Arpita. 2016. "Extending Boundaries of Blue Ocean Strategy." Journal of Strategic Marketing 24 (6): 519–28. https://doi.org/10.1080/0965254X.2015.1069882.
23	Rasool, Faisal, Pisut Koomsap, Bilal Afsar, and Babrak Ali Panezai. 2018. "A Framework for Disruptive Innovation." Foresight 20 (3): 252–70. https://doi.org/10.1108/FS-10-2017-0057.
24	Flavin, Michael. 2021. "Disruptive Innovation and Technology Enhanced Learning." The Psychology of Education Review 45 (1): 17–25
25	Christensen, Clayton M., Rory McDonald, Elizabeth J. Altman, and Jonathan E. Palmer. 2018. "Disruptive Innovation: An Intellectual History and Directions for Future Research." Journal of Management Studies 55 (7): 1043–78. https://doi.org/10.1111/joms.12349.

26	Kilkki, Kalevi, Martti Mäntylä, Kimmo Karhu, Heikki Hämmäinen, and Heikki Ailisto. 2018. “A Disruption Framework.” Technological Forecasting and Social Change 129 (April): 275–84. https://doi.org/10.1016/j.techfore.2017.09.034.
27	Pisano, Gary P. 2015. “THE BIG IDEA You Need an Innovation Strategy.” Harvard Business Review june 2015.
28	Ansari, Shahzad Shaz, Raghu Garud, and Arun Kumaraswamy. 2016. “The Disruptor’s Dilemma: TiVo and the US Television Ecosystem: The Disruptor’s Dilemma.” Strategic Management Journal 37 (9): 1829–53. https://doi.org/10.1002/smj.2442.
29	Lundgaard, Stine Schmieg, and Claus Andreas Foss Rosenstand. 2019. Investigating disruption a literature review of core concepts of disruptive innovation theory. http://hdl.handle.net/11159/3118.
30	King, Andrew A, and Baljir Baatartogtokh. 2015. “How Useful Is the Theory of Disruptive Innovation?” MITSloan Management Review 57 (01): 77–90.

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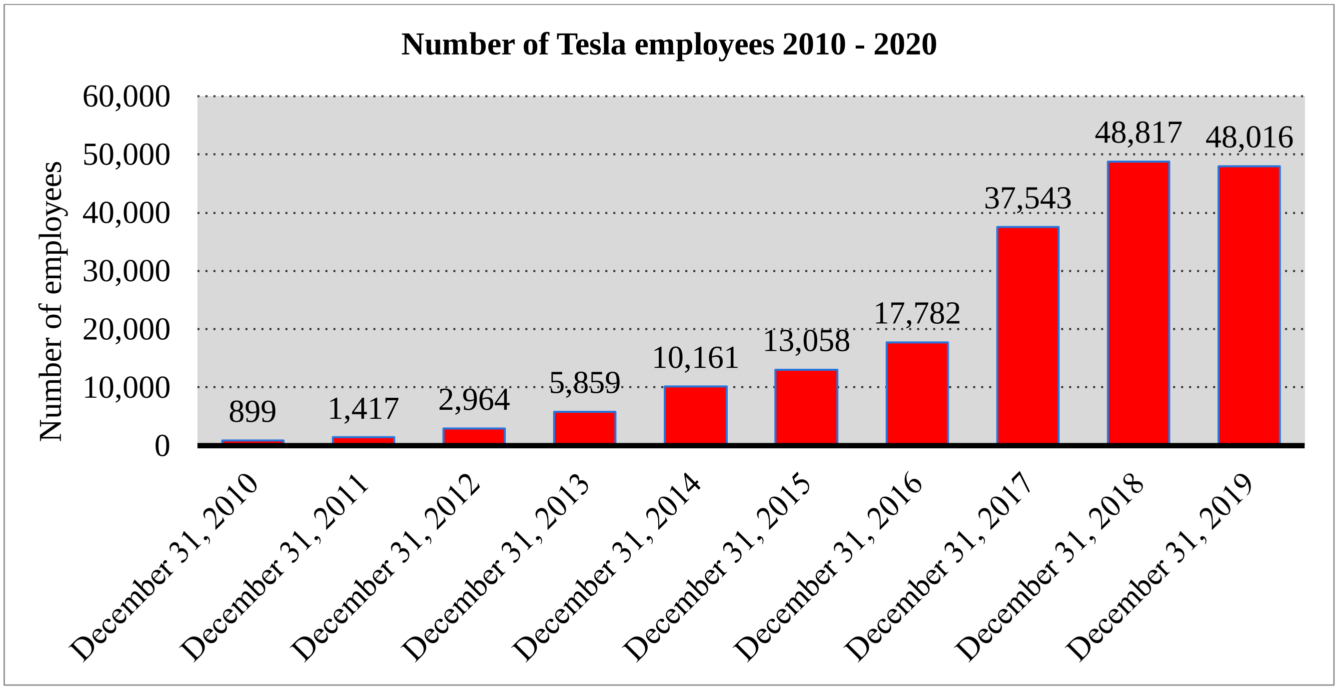
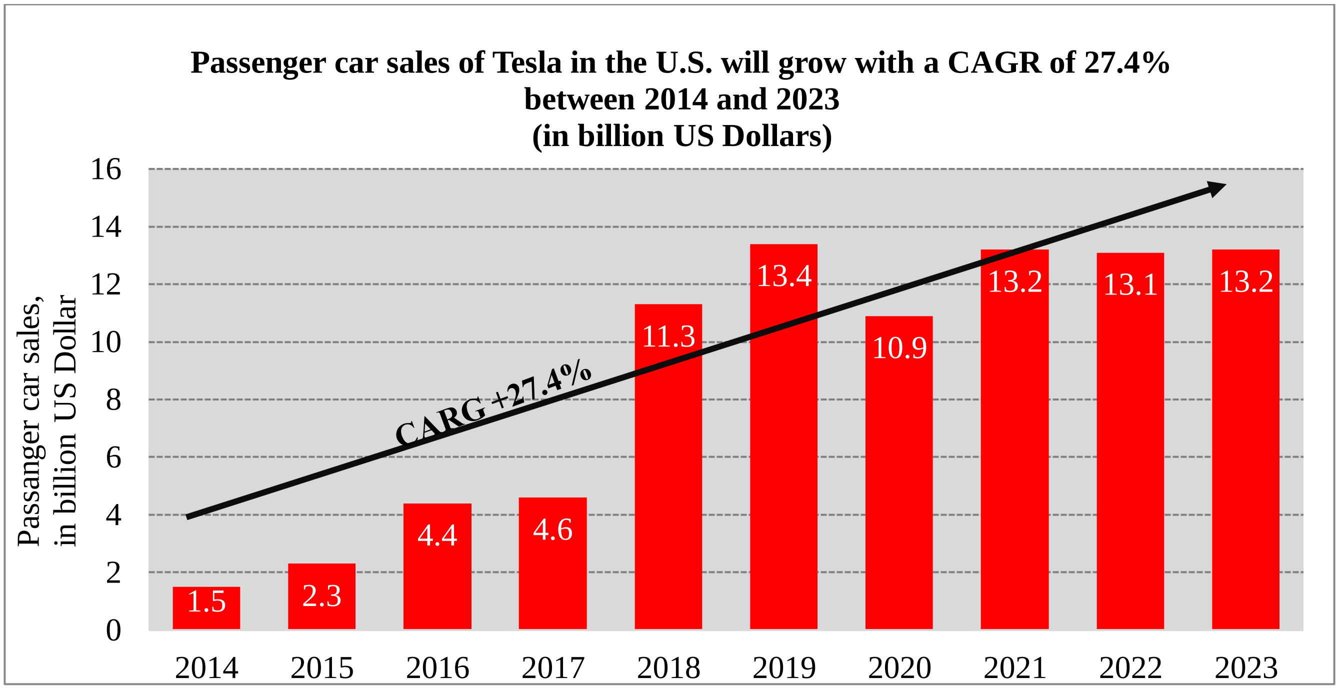
Figure 32



(Statista 2021d)

Figure 33



(Ahlswede, Oloruntoba, and Andrades Sanchez 2020)