Navigating the Digital Highway: A Case Study of Volkswagen Group's Cariad and a Make-or-Buy Decision

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Dissertation written under the supervision of

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ABSTRACT

This Case Study is about the Volkswagen group and its subsidiary Cariad. Volkswagen is one of the worldwide biggest original equipment manufacturers groups in the automotive industry. Since the automotive industry is affected by the digital transformation VW must face several challenges to remain competitive. In the wake of digitalization, automobile manufacturers around the world are trying to develop a software to enable cars to drive autonomously. Autonomous driving vehicles seems to be the big innovation that the digitalization brings into the automotive industry.

Due to the increased demand for digital products, Volkswagen established Cariad in 2019 to concentrate the group's research and development department and provide its brands with innovations for software-driven vehicles.

However, lacking in software development expertise the company faced a make-or-buy decision regarding its development for self-driving cars. The options are to develop it in-house, enter joint developments or to buy the software as soon as the market permits.

The Dissertation includes a Literature Review of topics related to the issues raised by the Case Study such as disruptive innovation, vertical integration, and transaction cost theory. Furthermore, a Teaching Note is offered to assist instructors in in-class discussions, evaluating the impact of digitalization on VW and its strategic approach for a successful digital transformation.

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RESUMO

Este estudo de caso é sobre o grupo Volkswagen e a sua filial Cariad. A Volkswagen é um dos maiores grupos mundiais de fabricantes de equipamento original na indústria automóvel. Uma vez que a indústria automóvel é afetada pela transformação digital, a VW tem de enfrentar vários desafios para se manter competitiva. Na sequência da digitalização, os fabricantes de automóveis de todo o mundo estão a tentar desenvolver um software que permita que os automóveis conduzam de forma autónoma. A condução autónoma de veículos parece ser a grande inovação que a digitalização traz para a indústria automóvel.

Devido ao aumento da procura de produtos digitais, a Volkswagen criou a Cariad em 2019 para concentrar o departamento de investigação e desenvolvimento do grupo e fornecer às suas marcas inovações para veículos movidos a software.

No entanto, a falta de conhecimentos especializados em desenvolvimento de software obriga a empresa a tomar uma decisão de compra ou venda relativamente ao desenvolvimento de veículos autónomos. As opções são desenvolver internamente, participar em desenvolvimentos conjuntos ou comprar o software assim que o mercado o permitir.

A Dissertação contém uma Revisão da Literatura sobre temas relacionados com as questões levantadas no Estudo de Caso, tais como inovação disruptiva, integração vertical e teoria dos custos de transação. Além disso, oferece uma Nota de Ensino para auxiliar os instrutores nas discussões em sala de aula, avaliando o impacto da digitalização na VW e sua abordagem estratégica para uma transformação digital bem-sucedida.

Título: Navegando na Rodovia Digital: Um estudo de caso da Cariad do Grupo Volkswagen e una decisão de fazer ou comprar

Autor: Lorenzo Giovanni Castrovinci Callecchia

Palavras-chave: Digitalização, Indústria Automóvel, Integração Vertical, Inovação Disruptiva, Teoria dos Custos de Transação, Make-or-Buy

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LIST OF ABBREVIATIONS

OEM	Original equipment manufacturer
R&D	Research and Development
SDV	Software defined vehicles
VW	Volkswagen

1. CASE STUDY

By August 2023, the pressure was heavily on Peter Bosch, CEO of Cariad, to develop the software for making an advanced autonomous vehicle functional.
Cariad was the business unit responsible for software development for the entire Volkswagen Group. Established four years earlier in Wolfsburg, Germany, under the name of “SW Org Wolfsburg AG”, the subsidiary in charge of developing the operating systems and other software components for the brands' cars had its name changed in 2021. "CAR, I Am Digital" was the idea behind the new business unit and was equally intended to indicate the new direction of the VW Group. The Board had already set in motion the goal of bringing around 80 new electrics around 80 new electric cars to market by 2025. Now it was no longer the mechanics of a car that were the driver for success, but the software. An area in which VW was lagging in development and had already been overtaken by other OEMs and technology companies, especially from Asia and the USA. Start-up difficulties at CARIAD showed the clear lead that the other competitors already had and thus the VW Group and CARIAD had to make a strategic decision in terms of internal organization. In-house software development with CARIAD lacked expertise, resources, and experience to competitors was not guaranteed. The group's idea was to turn away from the original strategy and generate the necessary success with the assistance of other companies.
The help of partnerships or suppliers was essential, especially regarding the big goal of not only bringing new electric cars to market by 2025 but also equipping them with software that enabled autonomous driving. VW lost its strong market position in a particular segment that software-driven cars represented. Tesla was the prime example of the global automotive industry (Exhibit 1). But Tesla was not the only new competitor for VW. Technology companies such as NVIDIA, Google, Apple, and Microsoft became potential suppliers of software systems for cars or new cooperation partners. Thus, with CARIAD, the group was faced with the question of whether to develop the software for autonomous vehicles in-house, purchase it, or develop it together with partners.

1.1 THE VOLKSWAGEN GROUP

1937 Wolfsburg, Germany, the birth of “das Auto” which means “the car”. Commissioned by the government of the German Reich, the engineer and car designer Ferdinand Porsche was to develop a car for the general population that would be affordable and reliable. The result was the legendary car called “Beetle” and the establishment of the Volkswagen company (Exhibit 2). The name Volkswagen stands for the vision the government and Ferdinand Porsche had and means “People`s car” because it was made for everyone. The batch production of the Beetle started in 1945 after the Second World War and became an export hit for Germany. With the worldwide attention, Volkswagen (VW) successfully helped in the reconstruction of the country and to rebuild its image and economy. Hence, the Beetle became one of the best seller cars. Over the years, VW has evolved into one of the largest automotive groups in the world and still stands for German engineering.

VW became one of the biggest group of companies in the world. A huge network and more than 119 production facilities in ten countries employed about 675,800 people worldwide. The group was able to generate an EBIT[1] of 22 billion euros through the sales of more than 8 million cars in 2022. The company became an international group of automobile suppliers with a wide range of vehicles covering various segments. Ten brands from five European countries belonged to the VW group, classified into three categories (Exhibit 3): Core, Progressive, and Sport Luxury. The category “Core” includes VW, Volkswagen Commercial Vehicles, Škoda, Seat, and Cupra. They represented low to mid-prized cars and had its own identity. Brands from the “Progressive” category were Audi, Lamborghini, Bentley, and Ducati whereby the last one produced exclusively motorcycles. These four brands represented cars and motorcycles for the higher price segment and stood for luxury and a unique driving experience. Porsche was the last OEM of the group and had a special position. Porsche was the sole representative of the category “Sport Luxury” and stood for the best German engineering and rarity. In addition, it had a proper tradition and special history that created a connection to VW. This was because the same developer of the Beetle was the founder of the brand, Ferdinand Porsche. All brands worked together for the success of the whole group, but independently. Therefore, every single OEM benefited from the synergy effect within the group to shape its future. The brands that the VW group acquired over the years represented unique characteristics and features. VW’s leadership wanted to maintain these distinct marketing features. Every car manufacturer remained differentiated, with its characteristics, and independent strategic direction. The differentiation among the brands was one of the most important aspects of VW’s strategy because of its unique selling point and the basis for a portfolio of software products.

The history of cars illustrated many trends regarding customers' expectations. Cars started to be a means of transportation for people and goods and had to be affordable and reliable.

[1] Cariad, 2023

Till today the expectations for cars and its technology were overwhelming. Once the automobile was made for everyone, people asked for more engine power, high-quality interior, and different designs. The demand become bigger and more specific in many aspects, with people interested in digital products, in its efficiency and sustainability. The automobile was more than a means of transportation and became a status symbol.

1.2 THE BIGGEST TRANSFORMATION PROCESS IN ITS HISTORY

The automotive industry underwent different challenges in the history of the automobile. In the last decades, it was the digital transformation that affected every industry in a specific way. Most industries dealt with the digitalization process to make work sequences faster, easier, and cheaper. Therefore, internal processes changed but in many industries the products remained the same (e.g., assurance or energy industry). Global car providers had to handle the digital transformation for internal processes and to fulfill customers' expectations of a car being digitally advanced. With the growing demand for electric vehicles, technology, and digital products, software became more important. The technological progress of a brand ensured more security and better performance and created the opportunity to stick out from the competition. Software has become a huge factor in customers' purchase decisions. Hence, OEMs had been working for years on innovations to satisfy customers and reposition themselves in the market. Regarding developing software or digital products, it was just the beginning for the automotive industry. In this case, manufacturer competed with a new technology sector for those software products where actors had a long history, outstanding research, and high development levels. Now competitors were not only other OEMs, but technology giants such as Apple, NVIDIA, Google, Microsoft, and many others. Apple entered the market with its idea of the "Apple Car" and software features for the broad market, Google started working on autonomous driving cars with its subsidiary Waymo as other companies like NVIDIA, Baidu, or Intel.

The entry of these companies changed the competition in the automotive industry. It increased the pressure to innovate on producers like VW. Changes in the market and internal organization of automotive OEMs became inevitable. Companies counteracted the expertise and know-how of technology companies by increasing investments to develop new software to remain competitive in this area. Increased investment in this specific area of development was changing the importance of software engineering professionals. IT therefore became increasingly important and a pillar for the development department of an automotive supplier. The software and technology competencies of the producers were increased to offer the automobile as a product fulfilling the requirements of the consumer from a digital respective. OEMs had to adjust its corporate cultures to have the requisite development success. The era of the automobile has evolved, requiring agile working practices and a greater emphasis on software development than in the past. Maintaining the established history and reputation may be challenging if the brands' key differentiator changes.

Overall, the automotive industry has been compelled to adapt faster to changing technology and consumer needs due to competition from pure software companies. It had led the automotive and software industries to increasingly converge, spurring the creation of innovative, connected vehicles. However, the transformation process presented the tech giants not only as competitors but also as potential partners for future projects.

1.3 CARIAD

Volkswagen had many challenges as a company group regarding the internal organization and the development of cars. Throughout the acquisition process of the brands over the years, VW did not merge the strategic or development departments of the companies. Maintaining its own identity and market position was very important. Since the organization within the companies had not been changed, the OEMs kept its structure and continued to run its production, strategic planning, and software development departments. With the digitalization process and the entry of big technology companies into the market, the group realized that software development was not on par with the competition. A certain degree of fragmentation slowed down the group's development processes, which resulted in a decentralized organizational structure. It inhibited the efficiency and scalability of the resulting products. Central control and coordination of the development of software and electronics was supposed to enable the use of synergies. Therefore, improved management of the expanding demands for electromobility and other technologies was necessary to maintain competitiveness.

The VW board, chaired by former CEO Herbert Diess, realized that the business unit for software development and electronics had to be centralized. The goal was to regain the lead lost by the competition with the help of one development unit for the entire group. To centralize the development of software and electronics VW established a subsidiary called “Cariad”, to capitalize on its software and technological knowledge. Cariad therefore combines the software capabilities of all VW group brands as a cross-functional business. The establishment in 2019 bundled the software expertise of every group’s brand. With its headquarters in Ingolstadt, Germany, more than 6000 employees in

Europe, China, and USA worked on the development of software in an automotive context[1]. The times of lack of focus in software development were supposed to end with its foundation. High investments were made to assist Cariad in accelerating digital transformation, fostering the creation of cutting-edge software solutions, and influencing future mobility.

The CEO of Cariad, Peter Bosch, was a high-level strategist and former board member in charge of manufacturing at Bentley. As a leader of the centralized department for software development, Peter Bosch was facing many challenges. In addition to the development of infotainment systems, software that increased the safety of a car, and solutions for charging control of electronic cars, Cariad is dedicated to autonomous driving.

1.4 THE BIG THING: AUTONOMOUS DRIVING

Autonomous vehicle technology has been proposed for many years. However, for a very long time, technological advancement was not capable of putting it into practice. Since the 2000s, numerous businesses have worked to apply the concept. Automotive OEMs, its suppliers, and tech firms were all actively working on it. The advancement of artificial intelligence, sensor technology, computing power, and communication has boosted the viability of self-driving automobiles. Directly related technologies for autonomous driving were already in use and very well-liked by consumers (Exhibit 4 & 5). Driving aid technologies, including adaptive cruise control, lane departure warning, emergency braking help, blind spot warning, and parking assist significantly improved the driving experience and safety, while also lowering a car's lifetime depreciation.

Autonomous driving, commonly known as self-driving vehicles, referred to a vehicle's capacity to operate safely and effectively on the road without a driver. Due to this technology's significant reliance on hardware, several sensors (such as radar, lidar, and ultrasonic sensors) and cameras were required to scan the surroundings around the vehicle. External elements are perceived, such as details about other drivers, the state of the road, and potential risks collected. AI algorithms and machine learning were used to manage the collected data so that prompt judgments might be made to guide the car safely. Customers would be able to accelerate, brake, turn, and overtake autonomously due to the new software, which recognized road signs and maintained a safe distance from the vehicle in front of them. The new software component promises to improve safety by lowering human error, among other dangers. The goal of the creators is to improve driving efficiency through autonomous driving, which entailed lessening traffic and making better use of the available road space. Physically handicapped people could benefit from this new type of mobility and live more independently. Although the idea of software-driven technology showed many advantages, autonomous driving faced challenges. Along with concerns regarding safety and coexistence of human-driven vehicles, there were legal and regulatory challenges. To exploit the full potential of this technology, companies around the world (including Cariad) were investing in its development.

1.5 THE MARKET OF AUTONOMOUS DRIVING CARS

1.5.1 THE TECHNOLOGY

Automotive OEMs all over the world produced automobiles that contained pieces of technology that were necessary for self-driving cars. Accordingly, autonomous driving technology for cars was categorized into six stages (Level 0-5). Level 0 described cars with no automation at all. Level 1 explained the driver assistance category where cars contained some automated features but still required a person to drive. Level 2 cars were partially automated ones. These were cars with advanced driving assistance systems that were able to take over, steer, accelerate, and brake in certain situations but still required driver's attention. Conditional automated cars were described such as level 3 that required driver's intervention just in severe conditions. Level 4 reflected a degree of high automation but might not operate in all scenarios. In those cars, the driver was not necessarily ready to take over. Level 5 was a fully automated self-driving car in which the rider just set the destination. With the gradual implementation of the technology in the market, the development was advanced, and the customers were educated regarding the new trend of development in the automotive industry.

1.5.2 MARKET AND COMPETITORS

Since customer expectations were changing along with the advancement of technologies, a new trend was evident. Customers throughout the world had a similar opinion of self-driving automobiles. Approximately 47% of respondents were willing to use a partially driverless automobile (Level 1-3) and 44% were willing to use a completely autonomous car (Level 4-5) (Exhibit 6). Experts forecasted a great demand and increasing sales of cars with such technological progress. From 2019 to 2030 global sales of over 194 million cars that can drive autonomously were expected (level 3-5) (Exhibit 7). This corresponded to a market size of over 61 billion US dollars for the year 2026 (Exhibit 8). VW planned to provide customers with cars with level 4, vainly. Competitors like Tesla, Mercedes-Benz, and BMW were ahead of VW and equipped its flagships with its latest developments. Mercedes Benz offered its customers the new S-Class and EQS models with a high level of autonomous driving (Level 3)[1]. Accordingly, these cars were able to drive themselves on German highways in traffic jams (up to 60km/h). Since 2023, self-driving cars may also be used on the roads of Nevada and California. The gradual implementation of this technology is mainly due to the different legal restrictions. The market of other European countries, China, and the rest of the USA may follow. BMW also reached the milestone of launching the first Level 3 cars. The BMW 5 series has even been allowed to drive autonomously at up to 130km/h on German highways since June 2023[2]. VW set itself the goal of launching cars with Level 4 standards on the market from 2025. However, compared to the market position of other OEMs, they were far behind.

To bring these advanced products to the market, Mercedes Benz and BMW cooperated with other companies. Daimler worked with the semiconductor manufacturer NVIDIA on a powerful AI platform for autonomous vehicles to implement in its vehicles. The partnership with Mobileye, acquired by Intel, was develop its existing driver assistance systems to advance autonomous driving to higher levels. BMW relied heavily on independent software development to protect its intellectual property. After a planned partnership with Mercedes Benz failed, they decided to focus on partnerships from the technology segment. For example, collaborations with Qualcomm and Arriver, which should help BMW develop a scalable platform for autonomous driving functions.

1.6 FILLING CARIAD’S WEAK SPOTS

The VW group started to invest in the development of autonomous driving before Cariad’s establishment. Higher investments were required to make up for the development losses through the missing expertise in comparison to technology companies and OEMs that started its software development. As the software for self-driving cars could be one of the greatest developments in the history of the automobile, this was another reason for Cariad’s high commitment to its department (Exhibit 9).

Cariad planned further investment in development intending to continue to be competitive at the forefront of the market. They considered autonomous driving as a critical aspect of the automotive industry's future, whose promise needed to be realized. The objective was to establish itself as a top supplier of cutting-edge mobility solutions and to influence upcoming technologies. Cariad was aware of the product's appeal and the rising consumers' expectations for the future. Long-term benefits from improved driving comfort and safety should cover the substantial development expenditures. Cariad’s engineers recognized growing obstacles and issues while working on the software. Before its foundation, software development was not the most important part of the VW group, so Cariad lacked expertise. The knowledge they missed by being late starters became noticeable. Despite Cariad's high investments in the "Autonomous Driving" project, it did not manage to reduce the lead of the competition. This was partly through the personnel structure and missing resources that such a project required. With slightly more than 6,000 employees, Cariad was significantly smaller than some of the companies in direct competition. Personnel with background in the creation of software for autonomous driving was lacking. In addition, they were compelled to divide its resources among several initiatives because the board also planned to build an infotainment system, an app store, and a new next-generation navigation system in addition to the software for autonomous driving. Furthermore, this forced Cariad to split its budget. Cariad struggled to make up lost time because they were smaller than most of its rivals. They had to advance in the race towards autonomous driving in to accomplish its goal. Working as quickly and effectively as the competition would not be sufficient.

1.7 CARIAD'S MAKE-OR-BUY DECISIONS

After Cariad worked independently to develop the software for autonomous driving and subsequently understood its deficiencies in some areas, the leadership rethought its strategy. Besides the "make alone" option, there were two other options to consider: joint development and buy.

Joint development involved working with one or more companies with identical goal pursuit. The choice of partnership could be freely determined, assuming that the partner company was also interested in such cooperation. The "buy" option aimed at stopping the development and buying the finished software product as soon as the market allowed it. All three options had several positive and negative arguments, but Cariad chose to collaborate with other companies to pursue its long-term goals.

1.7.1 CARIAD'S JOINT DEVELOPMENT

There were many types of joint development. Cariad referred to four of the possibilities in its strategic interpretation: joint venture, tender offers, merger & acquisition, and licensing.

Joint venture represented the establishment of a shared company between Cariad and a partner. Thus, both companies worked directly on the development of the product and jointly benefited from its success. The internal structure and profit distribution could be freely chosen. Cariad's tender offers were for the aid or external development of a sub-product. The demand for a certain partial solution was communicated publicly, whereupon other companies could deal with the tender and develop it for Cariad, or the existing product was handed over by licensing. This service went through numerous processes to ensure that the partner's solution properly met Cariad's requirements. Following the Request for Information (RFI), came the Request for Proposal (RFP), and finally the Request for Quotation (RFQ). In these steps, the compliance of the requirements for the service was checked and the price was negotiated. If both parties agreed, the software solution was developed and delivered specifically for Cariad.

Merge & Acquisition was an option used over all industries to grow as a unit. In this approach, Cariad could merge with another company and form a new legal and economic entity (Merge). Since a merger was often not desired by at least one of the parties, the purchase of a company or a percentage share was acquired (Acquisition). In this modality, Cariad benefited from the expertise and the development progress of the company.

The software development for autonomous driving was pursued with a wide range of partners following the strategic restructuring. The main objective was to develop essential software components in-house using various joint development options and to increase the depth of value added in the most important areas. In April 2022, Cariad acquired the automotive division of Intenta GmbH. Intenta was a German software developer specialized in sensor technology and object and person detection. This division had more than 100 R&D experts in the field of fusion of data collected by sensors. After the successful acquisition of the automotive division of Intenta, Cariad decided to enter a partnership with Horizon Robotics to form a joint venture. They established a joint venture in China, of which Cariad held 60%. Through this kind of joint development, Cariad profited from the regional expertise in China regarding the development of next-generation technologies for software-driven vehicles (SDV). ThunderSoft was a partner with which Cariad established a joint venture in China to accelerate its development in connectivity and infotainment systems. These cooperations were based on the expertise in software for SDVs but Cariad also started a partnership with a company that had its roots not in the automotive industry. In 2021 Cariad and Microsoft decided to build a cloud-based “Automated Driving Platform” (Exhibit 10). Cariad was able to accelerate the development of automated driving functionalities for cars across the groups’ brands thanks to Microsoft’s software expertise and tremendous resources, broadening Cariad's array of collaborations. In addition, VW intended to install chips in its future cars that were developed entirely by the semiconductor manufacturer Qualcomm. An independent not-for-profit organization called “Eclipse Foundation” was joined by Cariad because of its open-source community. Eclipse Foundations provided its members with work groups regarding its interests. Software companies like SAP and Google, universities with a strong research record, and even direct competitors like BMW were members of the organization. Therefore, Cariad became a strategic member of the working group for SDVs. As a foundation, it bundled the expertise and provided Cariad the opportunity to advance the development of innovation for SDVs.

Cariad made the deliberate decision to work with other firms to compensate for its weaknesses in the development of autonomous driving. They were able to speed up the process and save resources due to collaborations. As a result, Cariad did not bear the entire cost of development. Infrastructure and processing power were included, and personnel and financial resources as well. The joint development option enabled Cariad to collaborate with firms like Intenta and Horizon Robotics whose specialized competence had enabled Cariad to make progress in these areas at a pace that would not have been possible without very big investments in an independent kind of work ("make alone"). Furthermore, working alongside a technology pioneer such as Microsoft provided additional answers to data computing challenges and improved Cariad's chances of reducing time to market and catching up with competitors. Cariad was compelled to give up some control over the development process to reap the benefits of collaboration, although increasing the possibility that the final product would fall short of Cariad's expectations. Furthermore, it surrendered a part of its intellectual property, which was critical in the development of the software architecture. However, if the collaboration made the desired progress in the engineering process, it would be advantageous. As a result, the joint development allowed Cariad to gain access to other partners' technologies and intellectual property that they might not be able to develop on its own that quickly. Despite the many benefits of joint development, Cariad ran the risk of building some dependence on partners. The complexity of the project due to simultaneous collaboration with several partners could provoke conflicts of interest and create confidentiality issues regarding intellectual property. Still, Cariad saw the joint development strategy as a long-term solution for the development of new technology. The agreements for property rights and cooperation under the highest confidentiality were fundamental for a successful cooperation.

1.8 THE ALTERNATIVES

1.8.1 MAKE ALONE

The first of two alternatives were to maintain the strategy and keep developing the software for self-driving cars on their own. That meant that Cariad would not cooperate with any other company or foundation to bundle its resources and expertise with third parties. It was a strategy that protected intellectual property and allowed to develop the software independently without giving up any control of the project.

Cariad still had the opportunity to believe in the initial strategy despite its shortcomings. Many arguments opposed each other and depended on a common factor. The risk of not being able to develop the software. Upon successful completion of the development process, Cariad would retain all its intellectual property and remain independent. Therefore, Cariad would be the only one responsible for the high expenses. The high investment, building up of the infrastructure and technology for the development, and the extensive restructuring and expansion of the staff would be extremely high. Nevertheless, it could be worth the effort with the given expected return by assuming that autonomous driving was the technology to raise the automobile to another stage. In addition to the high level of investment, there would be a need for significant internal changes to compensate for the missing expertise in certain areas. Cariad would have to grow very quickly in many areas within a short time, which would limit the feasibility significantly. The risk of not being able to gain the missing expertise increased the risk of not being capable to place functional software on to market in the long run. This would mean that due to the successful development of the software, the competition offers technologically more advanced vehicles with which VW cannot compete.

1.8.2 BUY

If a corporation chose the "buy" option, it meant that the investment in the individual project was eliminated, and the finished product was to be purchased with a one-time investment. The "buy" option would indicate Cariad would accept not to invest in autonomous driving development until a competitor completes a workable software and sales it. This could include selling licenses or the entire product. One advantage of this strategy would be the ability to invest in other projects to differentiate from competitors with various capabilities and offerings.

In this case, Cariad would assume that the development of autonomous driving was not implementable due to too many requirements and restrictions and that the ongoing investments would not deliver the desired results. Cariad would be as fast as the market in case a competitor would be able to present the market a final product and willing to selling its license or the whole product. Consequently, Cariad would be forced to buy subsequent software packages as well and invest regardless in further developments for autonomous driving. However, if the software developer would refuse to offer the product or licenses, the Volkswagen group would be at a competitive disadvantage. Thus, there would be a danger that the group would fail to meet the needs of its consumers due to the uncertainty of having the possibility to purchase the final product.

1.9 THE FUTURE

VW planned to provide its customers the first autonomous vehicle with level 3 technology by 2025. The pressure was heavily on Cariad and its progress in developing the software to make such a vehicle functional. Just as in 2019 in Wolfsburg the board of VW decided to establish Cariad, in Ingolstadt Cariad’s leaders had to decide on one of the three options. Cariad's cross-functional role for the VW Group had to be strengthened. With this goal in mind, a solution should be found to regain VW's lost position in the digital segment of the modern car.

This decision indicated the long-term direction in which the company would grow and how to provide Volkswagen with the necessary advances in software development.

2 LITERATURE REVIEW

The following chapter aims to introduce the reader to relevant theoretical concepts for the analysis of the teaching note. The literature review will refer to the following concepts: Disruptive innovation, vertical integration, and transaction cost theory. These concepts will explain why it was so important for the industry to invest in the new technology and cooperate with other enterprises particularly with tech companies.

2.1 DISRUPTIVE INNOVATION

2.1.1 DEFINITION AND ITS PERSPECTIVES

Companies were more forced to drive constant innovation in the past due to the business environment's rapid change to remain competitive. Disruptive innovation is a type of invention that has grown significantly in popularity in recent years. This idea altered many different sectors' core ideas as well as how enterprises developed its business models. The current chapter of the literature review was devoted to a thorough analysis of disruptive innovation, including its definition, traits, and effects on markets and businesses.

Disruptive technology, as first defined by Clayton Christensen (Christensen, 1997), are fundamental conceptual or technological shifts that threaten established market structures and product lines. More broadly it is defined as disruptive innovation which should cover a wider range of cases. Furthermore, the theory of disruptive technology is expanded to include disruptions in other areas, such as goods and business models. This notion is known as disruptive innovation, which encompasses both disruptions in technology and other areas. (Christensen and Raynor, 2003; Hang et al., 2015; Markides, 2006). However the variations continue to convey the basic meaning of disruptive technology. (Alberti-Alhtaybat et al., 2019). This kind of innovations are distinguished by its capacity to open new markets or cover unfilled niches, although it is frequently first disregarded by major companies. Disruptive innovations are unique in that they gradually progress from solutions that appear to be inferior to disruptive forces capable of upending entire industries.

With further scientific works, Christensen and many other broadened the definition of disruptive innovation and its perspectives. In “The Innovator’s Solution: Creating and Sustaining Growth” by Christensen and Raynor in 2003, it is explained that disruptive innovations have its beginnings in low-end or new markets (Christensen et al. 2003). These innovations prevail because the companies emerge in markets that are overlooked or even deliberately ignored by established companies. This is the result when incumbents tend to provide only its most profitable and demanding customers with better and better products and services. As a result, less demanding customers with possibly different product requirements went underserved. This new demand opens the door for a disruptor to offer exactly those customers the desired product, even if it is only a niche (Christensen, 2006; Christensen and Rosenbloom, 1995; Christensen et l. 2003)). So, starting from a product that satisfied customers' expectations in a low-end or new market "smart disrupters improve their products and drive upmarket" (Christensen et al. 2015). Consequently, companies with disruptive innovation can compete with established companies in a specific market. That is why an adaptation to the coming changes is necessary. So, companies that adopt technology that later become widely used are more likely to be successful and thrive than those that do not, who are more likely to fail (Nair and Ahlstrom, 2003).

2.1.2 DISCUSSION AND IMPLICATION

Numerous articles have used disruptive innovation as a proforma reference, meaning that the theory is only mentioned in the paper's introduction or discussion part and not in the part that builds theories or formulates hypotheses (Christensen et al., 2018; Hall and Martin, 2005; Spinks et al., 2017). For instance, some studies simply pay attention to one or two parts of Christensen's initial research model while ignoring the others, which causes confusion in academic paper and practice (Daim et al., 2011). Other sorts of innovation may easily be mistakenly characterized as disruptive due to the unclear definition of "disruptive" in the first place. (Ardner R., 2002; Klenner et al., 2013; Christensen et al., 2018; Wilson and Tyfield, 2018; Li et al., 2018; Molina-Morales et al., 2019) As an example, Alberti-Alhtaybat et al.'s (2019) assessment of Apple's iPhone as a disruptive innovation is at odds with the notion of disruptive innovation due to the iPhone's exceptional performance, high price, and niche target audience. Chase adds to broad definitions and emphasizes that disruptive innovations can be those that make the use of excess capacity more effective. Uber is mentioned as an example. A company that has enabled private individuals to offer driving services with its cars to make profit with already existing capacities (cars) instead of working for a taxi company (Chase R., 2016). Further studies indicate that the theory of disruptive innovation must be seen as an evolving process. (Christensen and Raynor, 2003; Govindarajan and Kopalle, 2006; Christensen, 2006; Schmidt and Druehl, 2008; Hang et al., 2011; Guttentag, 2015; Ansari et al., 2016; Guttentag and Smith, 2017) They underline that disruptive innovation is not just an outcome, but a complete and progressive process. In this context, it is claimed that part of the process involves serving a particular customer base and being underestimated by established businesses. Only through this kind of procedure it is possible to drive upmarket with its innovation. One of the most important characteristics of a disruptive innovation, according to Christensen and Bower (1996) and Ruan et al. (2014), is, that an innovation alters the definition of performance or upends an industry's established trajectory of accomplishment.

Disruptive innovation must be defined clearly because if this fundamental issue is not addressed and the term is still allowed to be interpreted and applied loosely, the theory could easily veer off course. Managers could misuse the theory to make poor decisions that would lower its chances of success (Christensen et al., 2018). This would gradually cause the value of the disruptive innovation theory to decline (Christensen et al., 2015). The development of this theory is somewhat hampered by the concept of disruptive innovation's lack of clarity (Danneels, 2004; Govindarajan and Kopalle, 2006; King & Baatartogtokh, 2015; Cozzolino et al., 2018).

2.2 VERTICAL INTEGRATION

Vertical integration is a management approach in which a company extends its business activities across different stages of the value chain within its industry. This involves owning or controlling activities in forward and backward directions. The importance of this concept is that it allows companies to gain tighter control over its business processes, inputs, and outputs (Williamson O. E., 2010). "Thus, vertical integration brings upstream and downstream assets and production under unified ownership and control" (Riordan M., 2005). Companies choose the vertical integration approach to control costs, mitigate risks, ensure quality, and achieve competitive positions (Atalay et al., 2014).

2.2.1 FORWARD & BACKWARD INTEGRATION

Vertical integration can occur in two main forms: backward and forward integration. In backward integration, a company extends its control over suppliers or raw material producers to ensure the supply of critical inputs. This can lead to risk mitigation in case of supply disruptions and better control of quality (Loertscher S., & Riordan, M.H., 2019). Furthermore, it is a strategy to minimize prices for the necessary resources a company needs for its product. Profits are raised by the higher margin that the company can establish through backward integration (Church J., 2008).

Forward integration, on the other hand, involves acquiring or controlling distribution channels, retailers, or end customers. This allows companies to connect directly with end users and strengthen brand presence (Loertscher S., & Riordan, M.H., 2019). Since there is direct client interaction, not only can prices for the final consumer change, but also can change the essential services (marketing, customer service) required to generate the targeted sales (Loertscher S., & Riordan, M.H., 2019).

In general, the strategic decision to vertically integrate a company does not necessarily have to be the complete takeover of a venture or work step. Partial vertical integration is also possible if a company buys a stake in a supplier or customer upstream or downstream, possibly with only limited control rights (O'Brien and Salop, 2000).

2.2.2 IMPACT OF VERTICAL INTEGRATION ON THE MARKET

While vertical integration affects changing companies, it affects the market they compete with others. Various studies over the past decades have observed diverse consequences of the vertical integration of a company.

In 1986 Quirmbach published a study called "The path of price changes in vertical integration" which describes the following steps of a company after vertical integration. Accordingly, it says that in a variety of scenarios, vertical integration is pro-competitive. Because the integrated business expands its size by a significant amount after integrating, in the extreme, even the total foreclosure of the nonintegrated firms can increase consumer surplus (Quirmbach, 1986). A study by Riordan contradicts the theory and posits that no matter the degree of vertical integration, when the number of rivals rises, vertical integration becomes anticompetitive (Riordan M., 1998). Lafontaine and Slade summarize their findings as follows. The more concentrated a sector is, or in other words, the fewer nonintegrated competitors there are, the smaller the degree of integration is (i), and the more pro-competitive vertical integration is likely to be (ii). While result (ii) seems to be expected, result (i) may initially seem irrational (Lafontaine & Slade, 2007). Since the integrating firm's industry is more concentrated, vertical integration tends to have a higher possibility of becoming procompetitive. This can be said to be the most significant effect of the vertical integration of a company on other competitors and its market. (Loertscher, S., & Reisinger, 2014).

2.2.3 ADVANTAGES

Companies with a higher degree of vertical integration have different advantages to benefit from. It is of secondary importance whether a company is forward or backward integrated. Another important factor is the company's industry. Thus, companies from the automotive industry have different opportunities to vertically integrate than companies from the financial sector (Brickley et al., 2003).

The scientific community agrees that vertical integration has many advantages. Although the leverage of some of them varies from sector to sector and can be listed as follows: Better market insights, improved customer experience, brand building, increased profit margins, efficiency improvements, quick market response, and as a result a competitive advantage by a more vertically integrated firm (Church J., 2008 and Ray P. & Tirole J., 2004). Moreover, a higher degree of vertical integration ensures less dependence on other market participants and protection against retailers' power. This results in a reduction of transaction costs, which can be very high depending on the industry and market power (Williamson, 2010). Companies can achieve a stronger market position by offering clients specialized supplies and services while also optimizing its cost structures. (Porter M., 1980).

2.2.4 DISADVANTAGES

Since vertical integration is about the extension of processes and production steps, it increases organizations' complexity and its management effort. Because of this, managing later stages of the value chain requires effective coordination, which could be a vertically integrated company's downfall (Williamson, 1971). This is accompanied by the risk of overstretching the company which can lead to the loss of its core competencies and welfare (Williamson, 1971). The decision of further vertical integration is very binding, as it is cost-intensive and an intermediate step in the value chain. If it turns out that the production step in the value chain is affected by various market risks (e.g., price wars), higher exit hurdles can follow. In that case, it is very difficult for a company to go back to initial internal organisation. Cutting off the production steps which were vertically integrated can create additional costs and disorganisation within the company (Perry M.K., 1989). The cost of "exit" is highly dependent on the function and investment made for vertical integration.

High levels of vertical integration might prevent a corporation from innovating since they devote a lot of staff, infrastructure, resources, and money to internal control. Therefore, considering the aforementioned risks is equally necessary while making the strategic decision for a company to assume additional value chain processes (Harrigan K. R., 1984).

2.2.5 CONCLUSION AND IMPLICATION

Overall, it can be observed in several studies that vertical integration influences the respective company and the entire competition and all participants up to the end consumer. Companies see the decision to take over further steps of the value chain as essential in the long term. The decision to integrate depends on many factors such as market power and position, transaction costs and the efficiency of the company (Milgrom P. & Roberts J., 1990). The dynamic concept of vertical integration offers chances to grow and risks in a constantly changing world. It is not the ideal strategy for every enterprise when considering the positive and negative aspects mentioned above as well as its market impact. A certain degree of vertical integration can provide the right balance between external cooperation and vertical integration to maximize efficiency and competitive advantage. Therefore, companies should conduct an analysis to make the right vertical integration decision given its specific situation. Since, companies face different challenges they must be able to take appropriate measures to cope with it.

2.3 TRANSACTION COST THEORY

Transaction cost theory was first formulated by Ronald H. Coase in 1937 and by O.E. Williamson in 1979. The theories state that when a good is produced, coordinated, and influenced by the market, transaction costs are incurred, which may be higher than the costs that occur when transactions are integrated into formal hierarchies. Changing the way of operation within the company replaces the price mechanism and is found in the vertical integration of a firm (Coase, 1937). This insight was extended by Williamson (1979) and forms the foundation of a powerful theoretical framework for the study of businesses and its organizational structures (Williamson, 1979, 1989, 2010). Williamson presents his theory as one that focuses on the analysis of the costs generated in the conduct of transactions. This is to explain the process of decision-making by firms when choosing between market transactions and hierarchical transactions. Market transactions imply the company and the specific market, whereas hierarchical transactions take place only within the firm (Williamson, 1979). The resulting transaction costs have several cost components and reflect the total costs of planning and processing transactions. These consist of the following: Search and information costs, negotiation costs, contract design costs, monitoring costs, and execution costs. According to Williamson (1979, 2010), these costs are mainly driven by opportunity costs, uncertainty, and information asymmetry.

In the further course, this scientific work will refer to Williamson's theoretical approaches to prevent misinterpretation. Even though Williamson's approach is based on Coase's, they still have some differences in their assumptions and predictions, which can lead to misinterpretation. Williamson's transaction cost theory can be divided into six aspects.

1. Asset specificity
2. Hold-up problem
3. Opportunistic behavior
4. Incomplete contracts
5. Market vs. hierarchy decisions
6. Strategic alliances

These form the core framework of the theory and explain the organization of business activities and the managerial issue regarding vertical integration and make-or-buy decisions.

2.3.1 ASSET SPECIFICITY

Williamson (1985) examined the concept of asset specificity and its influence on transaction costs. This refers to specific investments made by a firm for a particular transaction. If the degree of specificity is higher, the risk of opportunistic behavior increases and with its associated transaction costs. Specific investments can be both financial and non-financial and are categorized into three types: Physical Asset Specificity (resources & facilities), Human Capital Specificity (human capital, training for employees), and Dedicated Asset Specificity (specific customer requirements). Asset specificity increases the degree of dependency on the parties involved, which can lead to a hold-up problem (Williamson, 1985).

2.3.2 HOLD-UP PROBLEM

The hold-up problem is part of transaction cost theory and describes the problem when one party, after making a specific investment in a transaction, tries to exploit its bargaining position to demand better conditions. It tries to persuade the other to make concessions that go beyond the initial agreements in the hope of achieving higher profits. This problem can occur especially in supplier-customer relationships with unequally distributed bargaining power. In addition, incomplete contracts are often mentioned as a cause of the hold-up problem (Klein B. et al., 1978).

2.3.3 INCOMPLETE CONTRACTS

These are contracts that do not cover all the details or contingencies of a transaction. This implies a degree of uncertainty about how certain situations or negotiations may develop. It is assumed that contracts are often incomplete, as it is impossible to include all possible contingencies which often arises concerning property rights (Hart O. & Moore J., 1990).

2.3.4 OPPORTUNISTIC BEHAVIOR

Opportunistic behavior of a party occurs after the execution of transactions when the party only represents its interests by trying to gain an advantage by not fulfilling initial obligations. Such behaviors are mainly provoked by incomplete contracts that contain serious loopholes. The combination of the two aspects of transaction cost theory can lead to conflicts between the parties and subsequently increase uncertainty and transaction costs (Williamson, 1985, Hart O. & Moore J., 1990). This is associated with an increased risk of the hold-up problem (Klein B. et al., 1978).

2.3.5 MARKET VS. HIERARCHY DECISIONS

The crucial decision between the market and internal organizations is an essential component of transaction cost theory. The central question is why a company prefers the market or its internal structures for the execution of certain transactions. Williamson's transaction cost theory states that a part of the total transaction costs is always incurred, regardless of whether the market or internal structures are used (Williamson, 1979, 1985). These include the costs of obtaining information, negotiating, monitoring, and enforcing agreements.

2.3.6 STRATEGIC ALLIANCES

In transaction cost theory, strategic partnerships reflect a solution to save costs. These cooperations do not only make sense from a financial point of view, as not only the costs are shared between the companies, but also its resources, knowledge, and capabilities to create synergies. The exchange between companies reduces uncertainty, the emergence of opportunistic behavior, and the risk of the "hold-up" problem. (Williamson, 1979).

2.3.7 CONCLUSION

Transaction cost theory has undergone a "natural evolution" that began with Coase in 1937 and has subsequently been adapted and is still cited today (Williamson, 1989).

Williamson's transaction cost theory is used across all sectors. Accordingly, it is an important component in the analysis for efficient decision-making on whether transactions should be handled internally or whether the market should be used. Studies unequivocally demonstrate that the theory directly addresses organizational architecture, the interaction between suppliers and customers, and a company's strategy, with the minimization of transaction costs and the containment of opportunism as its main objective

3. TEACHING NOTE

3.1 LEARNING OBJECTIVES

Using the example of the Volkswagen Group and the establishment of Cariad, the Case Study shows the influence of digitalization on the group, the industry, and its products. It illustrates the importance of continuous change to maintain the built-up market position and to be successful in the long term.

Disruptive innovation, vertical integration, and transaction cost theory are topics useful for students to explore the issues raised by the Case Study. Transaction cost theory is related to vertical integration and together they close the circle to the make-or-buy decision that must be made in companies in a wide variety of industries to be or remain competitive. Disruptive innovation represents a risk for those companies that are already competitive and underestimate the relevance of in-house development. The issues could be helpful in a course about corporate management, international business challenges, or strategy classes.

3.2 ASSIGNMENT QUESTIONS

These questions will guide students to prepare for an extensive discussion in class.

1) Why did Volkswagen establish Cariad?
2) What are the main problems of the group?
3) What are your recommendations for the manager of Volkswagen?

3.3 ANALYSIS

a. Evaluate the impact of digitalization on the automotive industry.

Digitalization has had a significant impact on almost every industry in recent decades. The automotive industry has been influenced by it and fundamentally transformed. Automotive manufacturers had to advance digitalization in internal processes and update the technology of its cars to the latest standards. Especially with the increasing demand for electric vehicles, the digital requirements of customers increased. The sustainable drive mode of electric vehicles was driven by digitalization and simultaneously demanded a change in vehicle's functions. The automobile became a more software-driven product as OEMs had to provide its customers what they expected to stay competitive. By creating the appropriate software for an automobile, performance, connection, safety, and infotainment could all be improved.

Technology companies and software developers joined the automotive market as its expertise and far-reaching technologies were in demand due to digitalization, increasing the market volume. It contributed to a change in competition, since the automobile, from the consumer's point of view, was no longer the same. The plan of a regular introduction of new models of the same series over a certain period was unpracticable. The market demanded a new automobile, with design and efficiency coming from a new perspective. OEMs had to differentiate its new products from the competition and convince with new design and performance data (e.g., battery ratings) to maintain its previous market position. These aspects created strategic uncertainty for OEMs and a trend prediction that was difficult to assess. In particular, the efficiency and safety of the new car models created development pressure among OEMs, which allowed brands to re-identify themselves.

Digitalization merged the automobile as a traditional OEM product with the latest technologies from other industries (e.g., computer software, smartphones). The software component became the core of a vehicle's architecture, opening the door for the industry to innovations such as autonomous driving and internal restructuring. Valued mechanical engineers were still important, but software engineers were necessary to drive new-age R&D and production (Industry 4.0). Overall, digitalization has revolutionized the automotive industry, presented new challenges to traditional producers, and allowed other companies to assert themselves with its disruptive innovations.

b. What were the main challenges that digitalization brought to the Volkswagen Group?

The digitalization process had an impact in various ways within the VW group. Regarding internal organization, workflows and production were digitalized to be able to produce cars of all kinds more cost-effectively and efficiently. Since nine automotive brands belong to the group, the extent of the adjustments was extremely time-consuming and cost-intensive. The new trend in the automotive industry created uncertainty in the group's strategic decisions, which meant that a new direction had to be taken despite a certain degree of skepticism. Internally, there was therefore a restructuring and addition of new business units.

The development of digital products, which became essential due to digitalization, created new competition that the VW group, as the global market leader, was not used to for several years. The development pressure from Asia and the USA clearly showed the backlog in R&D and created a market with new key players. Software engineering was the main driver of breakthrough innovations. German OEMs previously identified themselves through its traditional mechanical engineering. The turnaround in the industry caused a loss of its own image and in-house culture. The challenge was to integrate a new business unit which recovered the group to its regular position by catching up with the competition's lost development status in software engineering. Because of the late decision to invest in software development, the group lacked the expertise to make the desired advances. VW's staff was not comparable to that of a technology company or a competitor like Tesla, which was considered a pioneer of the electric car. Nevertheless, the group faced the hurdle of prioritizing its engine and transmission R&D on sensor technology, software architecture, and data analytics. Know-how, non-financial resources, and the infrastructure for developing SDVs were lacking for the group and presented a major challenge to catch up with the best competitors. Due to its weakened market position, VW lost its advantages vis-à-vis suppliers. They considered VW to be a highly dependent customer when it came to software-based innovations for cars.

However, the changeover was a hurdle for the group that was difficult to manage. Since VW has in the past placed a lot of importance on developing its cars exclusively in-house, they saw itself forced to collaborate with other companies to be able to produce the desired software in time. This change required the company to take on a new identity to be successful. The challenge was to move VW towards becoming a software company without losing its proper identity. A new personnel structure was necessary, requiring an academic background in IT and software engineering. Unconventional working processes and perspectives on the automobile as a software-driven product first had to be implemented and accepted by everyone, management board, employees, and customers. It can be said that the fundament for such a major evolution of the group had to be created first. The far-reaching changes regarding internal organization and customer expectations, and the management of partnerships confronted the group's executive board with its limits.

Digitalization has had an impact on business models and customer interactions. New opportunities to win customers also created new challenges. These include, meeting the new requirements for the driver experience, ensuring internal cybersecurity, and asserting itself in a market with new protagonists. In conclusion, VW has been challenged along its value chain by digitalization. A major shift and new legal environment for the entire industry forced the group to rethink its outdated strategies and ways of thinking. New strategic steps ensured high investments to be competitive in new segments of the automotive industry.

c. Evaluate Volkswagen's strategic approach to found Cariad.

Volkswagen's strategic approach to establish Cariad can be evaluated as a proactive response to the digital transformation and evolving landscape of the automotive industry. Cariad is a subsidiary of VW dedicated to software development and solutions of a digital nature. It was founded in response to the realization that software is increasingly essential in automobiles, and that it was necessary to position itself properly. Through Cariad, VW tried to vertically integrate the production step for the development of an increasingly central component of the modern car. The digital aspect of an automobile was vastly underestimated by VW. It turned out that these technologies were disruptive innovations, establishing themselves in the existing market and creating a new one as well.

Volkswagen showed foresight by recognizing the shift to SDVs and the increasing importance of digital innovations in the industry. The establishment of Cariad was intended to indicate VW's future direction and to take on a central role within the group. Before the establishment of Cariad, software R&D was decentralized. Accordingly, the group's nine brands each had its department, which may collaborate with each other. Cariad centralized the software development of VW. It made the process of research and development cheaper, more efficient, and more innovative through economies of scale and its cross-functionality. Communication was clearly defined by the subsidiary and served as a reference point for all brands. It facilitated the creation of in-house products which can be sold in different models of various brands. For example, groups' brands had the opportunity to request the development of a specific digital product that will be used in a Skoda, VW, Seat, and a low-priced Audi. Based on this, the requirements for the product were clearly defined, developed, manufactured, and then installed in the cars to be sold. The centralization of the group's software development separated this area from the traditional approach to design and to develop a car. The objective was to move R&D of new models away from the original non-software-based method to create new highly innovative cars that would be in demand for the long term. Exactly what the customer of the modern era demanded from an automobile.

Cariad introduced a customer-centric approach that focused on industry trends and digital features, with autonomous driving and related components taking a central role. In addition, Cariad should help the group to better control the digital product development and reduce external suppliers' dependency by creating an in-house software development unit. VW was facing the challenge of how to act strategically with Cariad to catch up with the competition. Future progress in development was to be driven by active exchange with other companies and foundations. The decision to engage in joint development allowed for partnerships with global companies with a high level of expertise in specific areas. These partnerships were opportunities to learn from the best and integrate the innovations into its cars.

Thus, Cariad bought Intenta's automotive department for the group. It also partnered with Horizon Robotics and ThunderSoft and established joint ventures in China to work with local experts on SDVs' next-generation technologies. Furthermore, it identified Microsoft as the resolution of its lack of infrastructure and non-financial resources. The joint development of an "Automated Driving Platform" represented a win-win situation for Cariad and Microsoft. Cariad got help in data processing and construction of such comprehensive software for autonomous driving. In return, Microsoft was allowed to work with an amount of data that only a company of its size could provide, which was essential for long-term success. Other forms of strategic alliances Cariad entered, were a partnership with the non-profit organization "Eclipse Foundation". It provided a network to promote cooperation in various areas. Such as, SAP, Google, BMW, and many other well-known companies benefited from the network and were able to work alongside them. The latter could also pose a threat in terms of intellectual property and the consequent registration of patents. The selection of cooperating companies and its interests is highly important, which was disregarded here.

Cariad had to deal with high development pressure since VW demanded quick results, which, however, failed to deliver. It underestimated the competition lead but also the hurdles that partnerships and founding a software company entailed. After all, VW knew how to develop cars, but not how software companies do. There was more to it than establishing Cariad, forming partnerships, and making investments. Collaboration among the partnerships also presented challenges. First, most of the partnerships Cariad formed with companies were not from the same region (e.g., China and USA), and second, they exhibited a stronger expertise. Cultural differences can make it difficult for two companies to work together, as different work ethics, approaches, and norms are key. In addition, asymmetry of information on the development of technological innovations slowed down the process.

In conclusion, the founding of Cariad was a late reaction to the turnaround in the automotive industry. It was intended to indicate a new direction, as VW noticed that the initial strategic concept was not up to date and could not offer customers what was digitally expected. Cariad's centralized function simplified the software and digital product development process, making it more efficient and accessible to all the group's brands. Therefore, it was an attempt to vertically integrate the software development process, but the approach of joint development clarified that VW was not successful in terms of being independent and secure intellectual property. The investments in software development through Cariad, and its collaborations and acquisitions other companies, rounded off the start of VW's new era.

d. What challenges can Volkswagen face in the future?

Volkswagen may face many challenges in the future due to rapid changes in the industry. Starting with digitalization and late establishment of Cariad, they may not be able to catch up with the competition. For autonomous driving, it's critical to create high-quality software that satisfies all commercial and legal standards in addition to creating software that works. Failure to catch up with the time lost and, most importantly, with technological progress would have far-reaching consequences.

It could cause financial losses like lost market share and decreased sales. Additionally, the market may offer a cheaper option for software development. If it becomes cheaper for an OEM to purchase a high-value software technology from a supplier than to produce it in-house, VW's dependence on suppliers may increase to remain competitive, or at least consider a change in make-or-buy decision. A section of the value chain would be lost, driving up expenses and internal uncertainty. Another challenge would be if technology companies start car production. Software companies are gaining more and more prestige in the automotive industry. Having already established themselves in the market with its software competencies, these companies could devote themselves to the in-house development of SDVs. This is mainly because the current core competence of technology companies is what the players in the automotive industry of the future must have to be competitive. Companies like Google, Microsoft, or Apple could vertically integrate car production. Such a large technological company entering the industry would raise significant worries about market share loss. These enterprises possess the necessary know-how to succeed in the automobile sector and innovation capacity, brand recognition, additional expertise in the digital space, and extensive financial resources. The defense of VW's market share would increase the pressure already placed on Cariad.

Moreover, with Cariad, VW will have to adapt to faster innovation cycles, which are atypical for a traditional car manufacturer. In-house software expertise will be very important for this. The difficulty for VW will be to attract highly competent software developers as well. Given the fierce competition for qualified people in the software business, Cariad and consequently VW must establish a reputation as a software developer that attracts and maintains talented employees. The challenge for Cariad's competence is to advance to the level of its top rivals.

VW's current market position is the result of early internationalization through globalization, the standard of high quality and reliability, targeted takeover of car brands, and the innovative strength in motorization. Due to the digitalization process, the latter will not be of high relevance in the long term, as it was in the 20th century. Through global production facilities and sales networks, VW can bring its new products to the market faster than most competitors. However, related areas of its infrastructure are becoming unusable. In the future, the much lower demand for spare parts will render large parts of its aftersales network obsolete. This is since SDVs powered by electrical technology consist of far fewer components, which consequently need to be replaced. Accordingly, a component that accelerated Volkswagen's success is expected to incur high costs in the future, thwarting the group. The economies of scale in production VW once had will not be in demand in software development. Startups will therefore be able to succeed by innovating in specific areas of software development for SDVs.

VW's challenge will therefore be to recognize disruptive innovations (e.g., car sharing) early and to build a brand portfolio for Cariad through selective acquisitions of companies, as they did previously with other automotive OEMs.

VW's future will strongly depend on Cariad's performance and standing in the digital automobile industry. It must remain innovative and agile to adapt to constantly changing dynamics of the market. The integration of software and hardware is undoubtedly the group's greatest challenge and offers Cariad opportunities to establish itself as a leader in the digital automotive industry. In addition, they will require further high investment from VW to increase employee quality and defend its existing position in the industry.

e. Evaluate the strategic alternatives open to Cariad and elaborate an approach to make-or-buy decisions on software.

Cariad used the strategy of joint development with other companies to be able to reach the goals in technological progress. In the make-or-buy decision regarding software for autonomous cars arguably one of the greatest innovations in automotive history, joint development has not only advantages. It should be noted that Cariad had to weigh important arguments in the decision that were unignorable. Moreover, the decision had to be in line with its strategic direction and that of the group. Since co-development can be accomplished in different ways, it is important to differentiate the methods.

If two companies join efforts to develop a particular product, complications may arise during the collaboration despite the initial agreement. This means there is always a certain risk of disagreement, which must be considered in the make-or-buy decision. Examples are cultural and regional differences, subsequent in-depth partnerships with companies, unpredictable disagreements in development, lack of flexibility, changing market conditions, conflicts in resource utilization, and many more. These risks affect simple R&D agreements, joint ventures, and collaborations through open platforms. Cariad, for example, concerns the collaborations with Horizon Robotics and Eclipse Foundation mentioned in the case study. Horizon Robotics is a company with which Cariad founded a joint venture in China. Despite the majority share of 60%, the aforementioned risks can occur. Open platforms for joint development, especially of software products, involved a higher risk of losing a larger share of intellectual property. The network offered by Eclipse Foundation contains companies that were operating in the respective field and direct competitors of Cariad and VW (e.g., BMW).

Other types of joint development that involve a binding purchase and thus a complete acquisition must be differentiated. Examples are the purchase of licenses for technologies or the acquisition of entire companies. The purchase of Intenta's automotive division is an example for this type of joint development. Through the acquisition, Cariad bought Intenta's expertise in sensor technology, its experience, and technological progress. This acquisition is not part of the "buy" strategy, since it is not the entire software for autonomous driving, but only a small part of the concept. Furthermore, Intenta remained a separate company and was only handing over the development division in the automotive industry. This method reflected a mix of make-or-buy options that reduced Cariad's weaknesses in development.

From Cariad's perspective, in-house development of the software for autonomous driving failed, which is why it is counting on partnerships. The make option is of great interest to a group like VW, as successful vertical integration of software development for vehicles represents a competitive advantage. Quality assurance is an important aspect to be able to work out such an advantage. VW would benefit from many advantages, including full retention of intellectual property and independence from competitors. However, a current make strategy would entail very high investments and quality losses, as Cariad's partnerships drive the development of many features. This would increase the risk of not being able to keep up with the competition. Furthermore, VW and Cariad would not satisfy expectations of today's software development. It lacks expertise and infrastructure, which are related to high investments, experience, and especially time. Time that VW does not have, which is why the partnerships were used to accelerate the process. Therefore, from today's point of view, a complete in-house development would have major disadvantages that limit the group's long-term goal.

The option of procuring all the software for self-driving cars would entail too many disadvantages that are not sustainable for a corporation like VW, assuming there was a supplier who would sell the software to the group. VW would have to forego investments to develop the product to then make a one-time investment to purchase the software. However, it would be necessary to invest in developing subsequent software, which is why VW would have to start over again. The lack of expertise, infrastructure, and experience in the field remains and would force VW into a great dependence on the supplier. Furthermore, it may be doubted that other OEMs could not also install the same software in its vehicles. This would mean that the implementation of autonomous driving cars would no longer represent a competitive advantage. It is important to mention that there is a certain risk that the software is not compatible with VW vehicles and requires further investments to meet the quality standards. In the future, the vehicles of car manufacturers will be differentiated by its software, among other factors. The purchase of software for autonomous driving could therefore present VW as a copying brand, which would lead to a loss of identity. The advantage of being able to implement the software in the group’s vehicles is just a limited advantage associated with too many serious issues.

The framework

The decision between making or buying a software or digital product depends on many factors. For this purpose, a framework is suitable that compares the most important factors and helps to make the right make-or-buy decision.

The framework consists of two essential steps: The categorization of the software product and the decision between "make alone", "buy", or "ally". The latter represents the decision to develop the respective software product in a strategic alliance.

The categorization

Categorization is about the correct classification of digital products. The intention is to obtain further assessments of the potential and the costs incurred for development. The potential of a software product depends on its longevity, degree of innovation, integrability, and the resulting expected revenues. Costs refer to all costs that would be incurred if the product were developed in-house. This includes in-house development costs, the aspect of time, and additional investments in infrastructure to be able to develop the product, if needed.

According to longevity, a product can either support a long-term trend or serve as a foundation for new innovations. The possibility for long-term revenue generating increases with lifespan. This relates to the idea of innovation's level. A software's lifespan and potential are higher the more inventive it is. Fundamental questions regarding whether the innovation already exists in some form, whether research has been started, or whether it is a disruptive innovation must be addressed in this situation. The last aspect is integrability. It is necessary for the make-or-buy decision to understand if the software that may be purchased (e.g., license purchase) can be implemented in the company's software's existing architecture and associated digital products. It defines whether the "buy" decision exists.

The last question to be answered for software categorization is that of relevance. How relevant is the respective software in the overall concept of a vehicle? An example in terms of Cariad and SDVs are infotainment systems. A digital product that is in demand, especially among younger customers but does not address the hard requirements of a car (e.g., safety, efficiency).

Make, buy, or ally?

Following the analysis to categorize a software product, it becomes apparent if the potential and the expected sales derived from it exceed the expected development costs. If this is the case, a strategic decision can be made about make, buy, or ally.

An important aspect of the decision-making process is the intellectual property related software development. If a software, brings with it high relevance and potential, intellectual property is very important (e.g., autonomous driving). In this case, in-house development through vertical integration is a serious option for the make-or-buy decision. However, the supply of the market and associated transaction costs must be respected.

Furthermore, the company's capabilities and resources are very important. This includes physical assets like technology, patents, assets for production and development, employee competencies, the scope of organizational processes, and financial resources. These factors must be considered on the uniqueness of a company's resources compared to its competitors. The higher the uniqueness, for example of employee competencies and patents, the higher the competitive advantage. Companies can use these insights to argue a make-or-buy decision, as these are difficult to copy. Significant differences between internal resources and those of competitors further guide the decision to develop independently or support the decision to collaborate with other companies. Therefore, competitors that have the resources where internal deficiencies have been identified can be considered as collaboration partners.

Cariad prefers cooperative development since it does not view itself as being on an equal footing with its rivals regarding software development for autonomous driving. VW is attempting to create Cariad entirely in-house, but they do not have the funding to do so. This is mostly because investments in digital breakthroughs and its R&D were made too late. It is feasible to try to make up for internal shortcomings in comparison to the competition, but doing so requires expensive investments that must be done very wisely. To quickly transition back to the route of its internal development, Cariad should employ its joint development strategy.

f. What are your recommendations for the top management of the Volkswagen Group?

My recommendation for the top management of the Volkswagen Group must be differentiated between the group and Cariad.

Making the appropriate choices is difficult given Cariad's questionable strategic position. Support is required for a long-term plan that aims to transform Cariad into the top software developer in the automotive sector. Due to the lack of expertise in this area through late, missing, and poor investments in the past, Cariad should make further investments to acquire targeted companies. As it has previously been the strategy to have a differentiated portfolio of automotive brands in the group, Cariad should similarly reflect a portfolio of companies covering diverse areas of digital technologies in the future. The companies acquired should be innovative and experienced. The goal is to compensate for Cariad's lack of expertise and development strength by acquiring upcoming companies. The evaluation of emerging technologies should also be carefully classified regarding its potential future significance and ability to identify potential disruptive innovation ideas at an early stage, especially in face of the rapidly changing automotive industry through digitalization. Moreover, the acquisition of software developers implies the successful implementation of the vertical integration of this step in the value chain. The labor market represents a great opportunity for Cariad to support its in-house expertise and compensate for Cariad's lack of skills. It needs to become an employer of highly skilled software developers who have a strong interest in developing innovative technologies for one of the largest automotive groups. After all, the long-term success of developing technology like autonomous driving largely rely on developers and its capabilities. Additionally, changes must be made to permit early insourcing and long-term planning. Continuous technological independence from the partners must be attained to support early insourcing, and maintenance of data sovereignty. Standardization of the infrastructure of software and hardware platforms must also be guaranteed. The speed in the development of software depends strongly on it and promotes long-term planning by evaluating technological trends for 5-10 years.

About the make-or-buy decision of software development for self-driving cars, it is advisable consider joint developments only as far as necessary to increase Cariad's expertise. Cooperation in the form of acquisitions of entire companies or business units should be continued to vertically integrate software development successfully. However, other forms of joint development like joint ventures should be considered and kept to a minimum to comply with intellectual property protection. Autonomous driving cars will be a big part of future OEM sales in my opinion. Nevertheless, there is still a certain amount of time for companies to develop the software and finalize the perfect automobile, as today’s legal guidelines do not allow a full implementation. The joint development of software is therefore recommended with specific companies if the software is not a digital product with significant relevance for cars’ platform (e.g., infotainment system) or a high-volume and long-term supplier to create lock-in effects. Nevertheless, it remains the approach that Cariad should take. Considering that Cariad conducts R&D for the Volkswagen Group, it's also critical to offer a thorough proposal. VW must consider other options despite the move toward electronic vehicles and digitalization. Research into alternative mode of drive is one example of this. The true efficiency of hydrogen-powered vehicles is yet unknown. Therefore, it could be an alternative to electric vehicles, as these also meet a lot of criticism relating to sustainability. This has no bearing on a vehicle's digitalization because it may be done regardless of drive. Additionally, the usage of hydrogen-powered vehicles could benefit present production networks in terms of the aftermarket.

I think, it will be essential for VW to continue its high investments for the successful establishment of Cariad. It will take time to cope with the development pressure and to achieve the desired market position, but VW has always been able to cope with such situations in the past. As we know, diamonds are created under pressure.

4 CONCLUSION

Volkswagen became a group with many valuable brands that represent emotions, performance, and automobile history. The challenges of digitalization that VW is facing will prove the group and its competencies to transform the group and provide software-based cars, that have a new basis of identification and may not represent the same values as before.

In this Case Study, I had the opportunity to highlight a topic that has been discussed a lot. Since cars became more efficient and environmentally friendly due to digitalization, in the future the influence will not diminish and will generate further innovations that will make driving safer and more comfortable. The thought of using autonomous cars one day can be scary, but it can also create many opportunities. For people with a high travel demand, it could help them to travel long distances autonomously and use the time to work or rest. Car manufacturers must make the move towards a software developer to remain sustainable and successful in the market with strong competitors. This case study helped me to understand the challenges of a car manufacturer and its organizational extent.

Due to the age of digitalization, customers' expectations are growing rapidly. I am curious about the next innovations for cars since the automobile for me represents a product with important history, emotions, and euphoria. It will be a challenge to maintain the image of a car and simultaneously implement more and more digital products. I would have liked to explore more a framework to use when it comes to make-or-buy decisions about software products since such a framework could be used in all industries that are affected by digitalization.

APPENDICES

CASE STUDY EXHIBITS

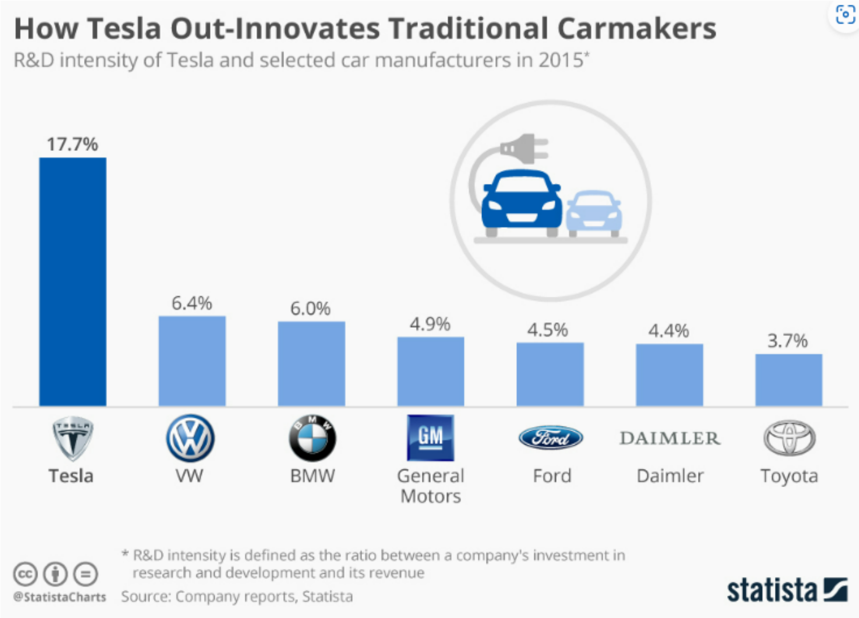

Exhibit 1 R&D intensity of Tesla and selected car manufacturers in 2015 (Source Statista)

Exhibit 2: The Volkswagen Beetle

Exhibit 3: The Volkswagen Group's brands (Source: Volkswagen Website)

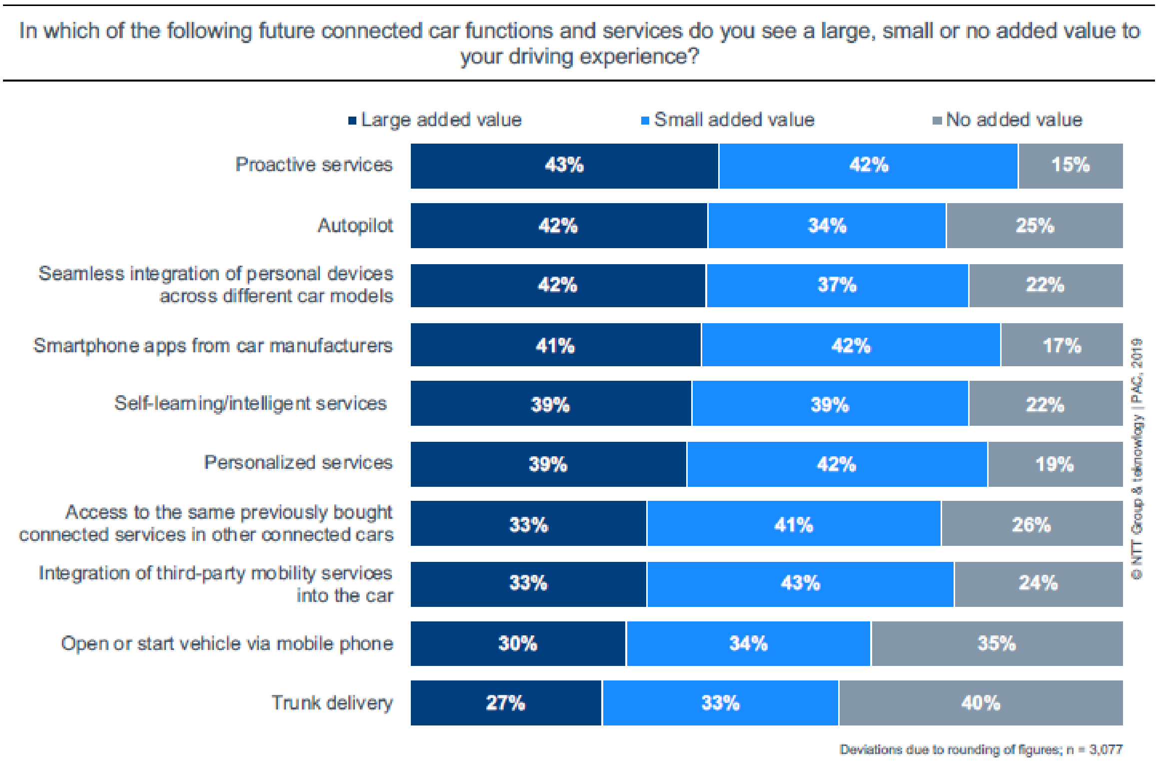

Exhibit 4: A survey regarding new technologies that may add value to customers driving experience (Source: NTT Group & Teknowlogy

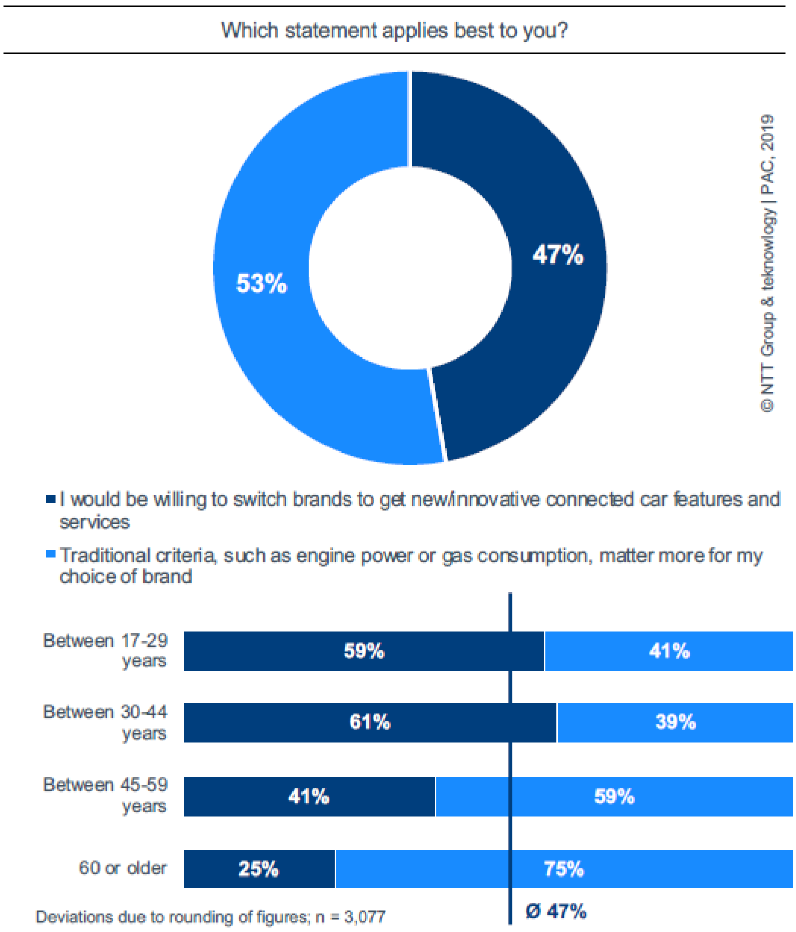

Exhibit 5: Brand loyalty by generations (Source: NTT Group & Teknoowlogy)

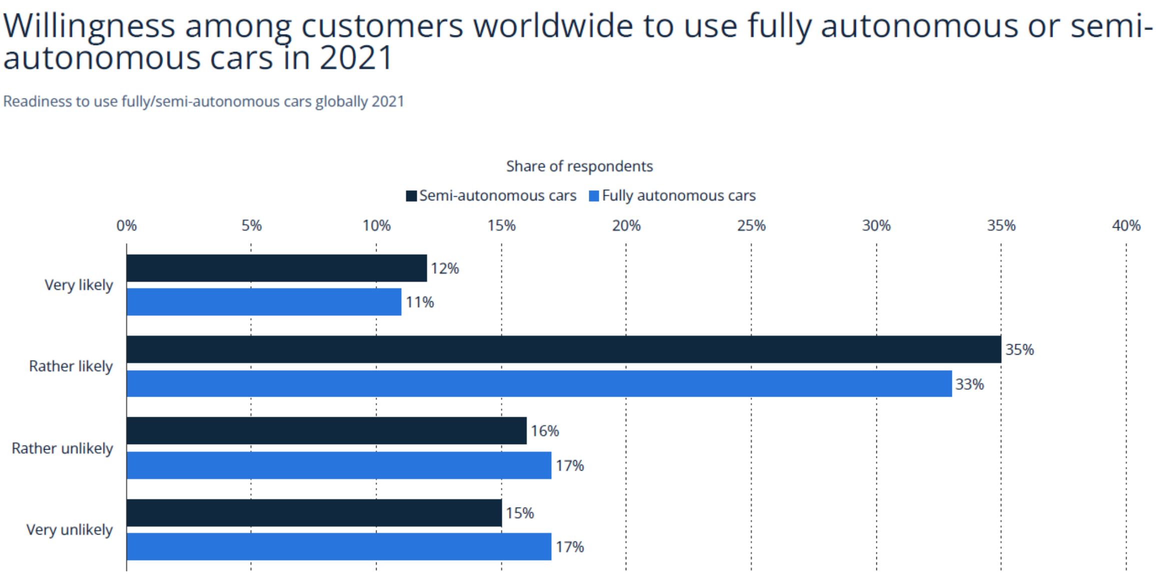

Exhibit 6: Customers' willingness to use autonomous driving cars (Source: Statista)

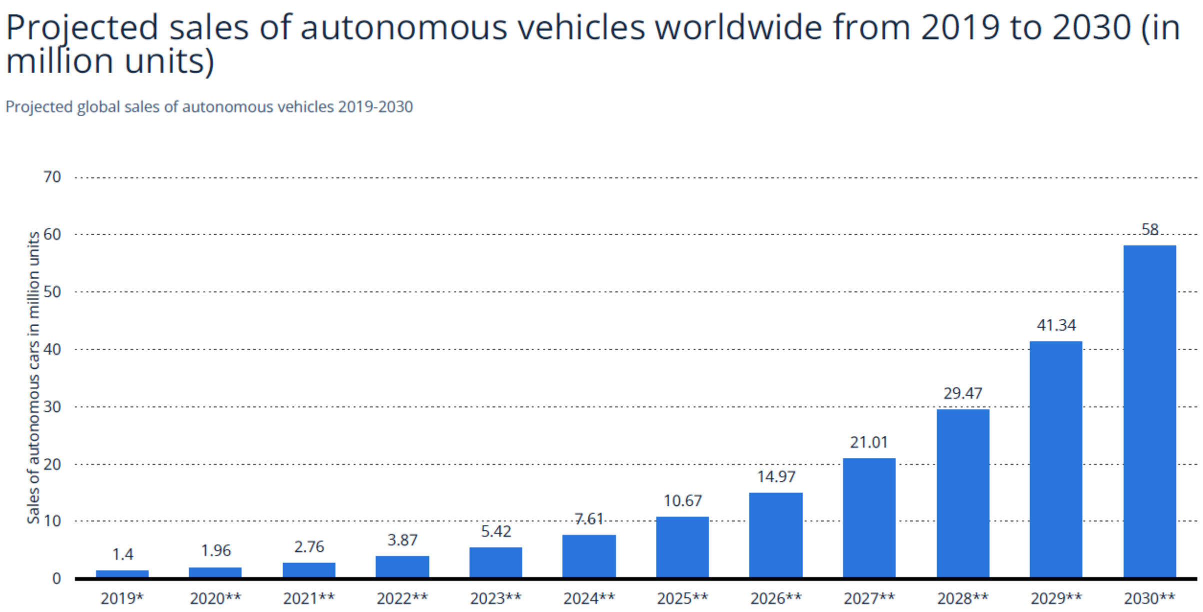

Exhibit 7: Projected Sales of autonomous vehicles worldwide (2019-2030) (Source: Statista)

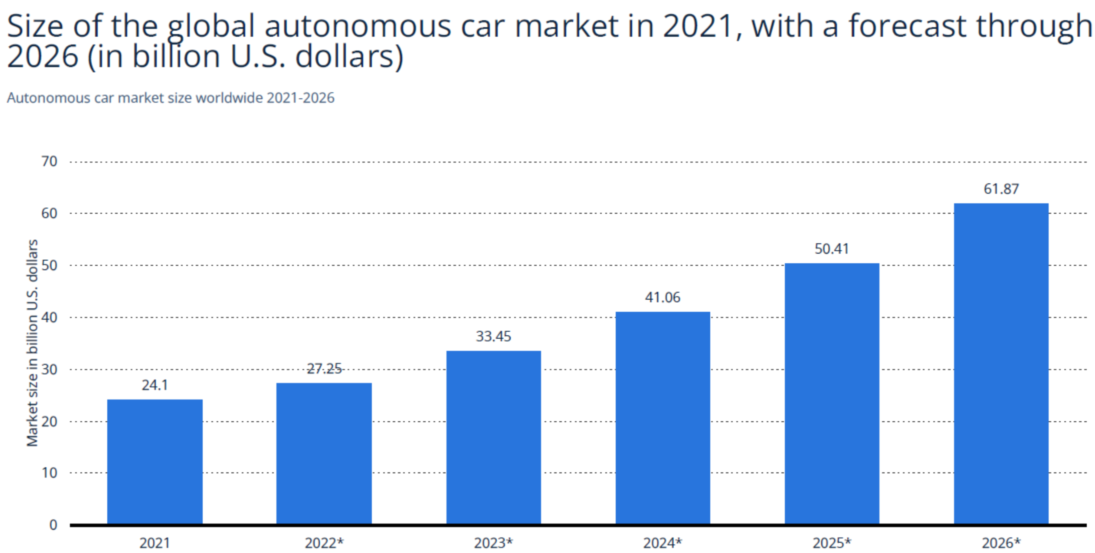

Exhibit 8: Size of global autonomous car market in 2021 with forecast through 2026 (Source: Statista)

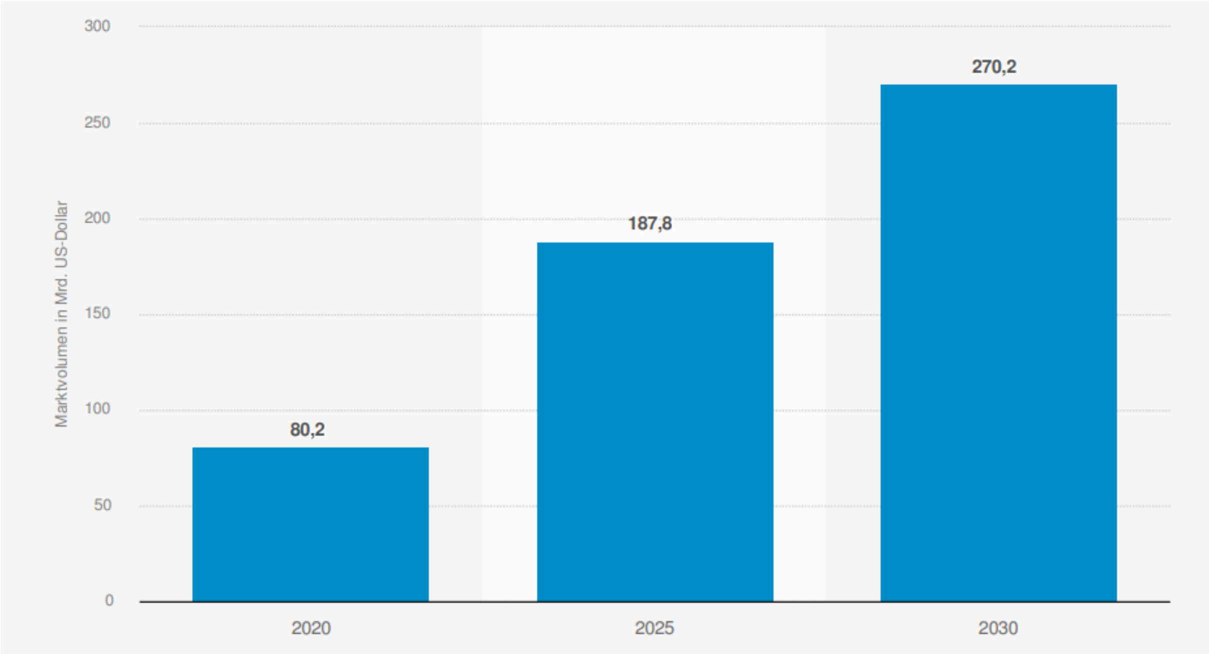

Exhibit 9: Forecasted global market volume of driver assistance systems and autonomous driving functions in Europe, China, and the U.S. from 2020 to 2030 (in billions of U.S. dollars) (Source: PwC, Statista)

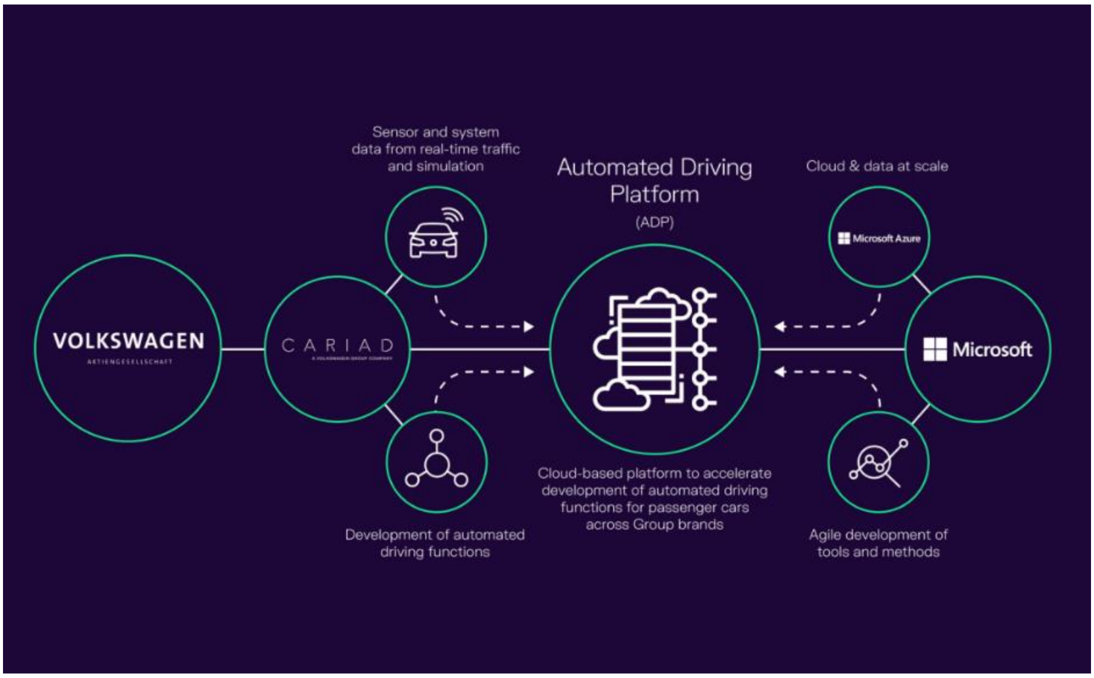

Exhibit 10: Automated Driving Platform

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