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Business Adaptive Strategies in Crisis: Navigating the Semiconductor Chip Shortage in the Automotive Industry

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Dissertation written under the supervision of Professor Nuno Cardeal

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Abstract

Title: Business Adaptive Strategies in Crisis: Navigating the Semiconductor Chip Shortage in the Automotive Industry

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Keywords: Chip shortage, Supply chain management, Adaptive strategy, Vertical integration, Dynamic capabilities, Resources, Production efficiency, Crisis management, Risk management

The following thesis, presented in the form of a case study, highlights the impact of the semiconductor chip shortage on the automotive industry and analyzes the adaptive business strategy employed by a well-known OEM (Original Equipment Manufacturer) to navigate the crisis. Despite all the efforts, several industry players struggled to sustain their business operations in one of the hardest hit industries, which led to severe supply chain disruptions. This case study explores how the analyzed company was able to successfully adapt to the changing market dynamics by examining its resources of competitive advantage and dynamic capabilities.

Semi-structured focus group discussions with employees and industry professionals alongside secondary data were used to investigate this topic comprehensively. Serving as a pedagogical instrument this study allows students to apply relevant theoretical frameworks to real-world scenarios providing valuable lessons and enhancing their understanding of strategic decisions, supply chain management practices and operational adjustments.

One notable finding underscores the need for flexibility and agility in times of uncertainty to respond swiftly to changes. The advantages of vertical integration within the supply chain also played a crucial role allowing the company to have a greater control over the processes. Another finding emphasizes the need for better risk management and the importance of accurate forecasting during crisis time.

Resumo

Título: Estratégias de Adaptação Empresarial em Crise: Navegando pela escassez de chips semicondutores na indústria automotiva

Autor: Mariann Vilma Vörös

Palavras-chave: Escassez de chips, Gestão da cadeia de suprimentos, Estratégia adaptativa, Integração vertical, Capacidades dinâmicas, Recursos, Eficiência de produção, Gestão de crises, Gestão de riscos

A tese a seguir, apresentada na forma de um estudo de caso, destaca o impacto da escassez de chips semicondutores na indústria automotiva e analisa a estratégia de negócios adaptativa empregada por um conhecido OEM (Fabricante de Equipamento Original) para navegar na crise. Apesar de todos os esforços, vários intervenientes da indústria lutaram para sustentar as suas operações comerciais numa das indústrias mais atingidas, o que levou a graves perturbações na cadeia de abastecimento. Este estudo de caso explora como a empresa analisada foi capaz de se adaptar com sucesso às mudanças na dinâmica do mercado, examinando seus recursos de vantagem competitiva e capacidades dinâmicas.

Discussões de grupos focais semiestruturados com funcionários e profissionais do setor, juntamente com dados secundários, foram utilizadas para investigar este tópico de forma abrangente. Servindo como instrumento pedagógico, este estudo permite aos alunos aplicar quadros teóricos relevantes a cenários do mundo real, proporcionando lições valiosas e melhorando a sua compreensão de decisões estratégicas, práticas de gestão da cadeia de abastecimento e ajustes operacionais.

Uma descoberta notável sublinha a necessidade de flexibilidade e agilidade em tempos de incerteza para responder rapidamente às mudanças. As vantagens da integração vertical na cadeia de abastecimento também desempenharam um papel crucial permitindo à empresa ter um maior controlo sobre os processos. Outra conclusão sublinha a necessidade de uma melhor gestão dos riscos e a importância de previsões precisas em tempos de crise.

Acknowledgment

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Lastly, I would like to express my gratitude to my family for supporting me in achieving this special milestone of my academic path.

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List of Abbreviations:

OEM - Original Equipment Manufacturers

AI - Artificial Intelligence

IoT - Internet of Things

R&D – Research and Development

EV – Electric Vehicle

ICE - Internal Combustion Engine

IC – Integrated Circuit

ECU – Electronic Control Unit

TFT – Taks Force Team

RBT – Resource-Based Theory

VRIO – Valuable, Rare, Inimitable, Organization

DC – Dynamic Capabilities

SWOT – Strengths, Weaknesses, Opportunities, Threats

JIT – Just-In-Time

MTS – Make-To-Stock

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1. Introduction

In this age of rapid technological advancements, our lives are more connected and convenient than ever before. However, with these developments comes a hidden challenge that has lately captured the spotlight – the chip shortage. Smartphones, laptops, cars, medical appliances, and several other devices contain semiconductor chips, a lesser-known hero silently holding everything together. This crucial component is the lifeblood of our digital existence powering our modern lives.

Beginning in 2020, this shortage has become more than just a bump on the road, especially within the automotive industry where car manufacturers rely heavily on these tiny chips. They are playing a crucial role in almost every aspect of automotive functionality in modern vehicles. The lack of these supplies forced the automotive companies to hit the brake on production lines, leading to significant delays and shortages at dealerships. Skyrocketing demand for new vehicles after the Covid-19 related shutdowns, increasing reliance on semiconductor chips, complex supply chain processes, geopolitical tension and several other external factors contributed to the disruption of the global supply chain.

While the majority of the firms failed in this chip war, some organizations have demonstrated resilience and managed to navigate the challenges with outstanding sales results. But how is it possible that many car manufacturers were forced to shut down their factories temporarily while others seemingly emerged unscathed from the chip shortage? The answer in a nutshell is the difference between the ability to create adaptive business strategies during crisis time.

In this case study we will analyze a strategy of a key player within the automotive sector, which not only survived but also thrived during the semiconductor crisis. In the beginning a high-level industry analysis will be followed by a more in-depth look into the external factors within the automotive sectors which led to the chip shortage. Afterwards we will delve into the company's standard and adaptive product planning as well as supply chain strategy. We will also uncover the secret behind their success, shedding light on the specific practices and resources that enabled them to navigate the chip shortage with resilience and agility. In the following section some theoretical frameworks related to the topic will be introduced to provide a literature background for the case study. Furthermore, a comprehensive analysis of the assignment questions will be presented. And lastly the final section will summarize and conclude the dissertation while also highlighting certain limitations of this study. Appendix and references can be found after the case study.

2. Methodology

One of the most important decisions when developing a research study is the choice of the applied research methodology, as it determines how the data will be collected (Aaker et al., 2018). The study adopts a case study approach to analyze how the semiconductor shortage has affected the production and supply chain strategy of a major OEM (Original Equipment Manufacturers) and how the company was able to apply successfully an adaptative strategy during crisis time. A case study is a type of qualitative research method that analyzes a unique situation within its real-life setting while requiring new qualitative data to achieve deeper understanding of the company's past, current and future strategy, and comprehensive research of the phenomenon (Crowe et al., 2011).

Primary data were gathered through three semi-structured focus group interviews with 14 professionals representing various roles within the automotive company. The Head of Section Carlines, Head of Department Product Strategy, Head of Section Product Planning, Product Managers, Product Leads and Product Planners shared their thoughts about the analyzed subject. These participants were selected for their expertise and involvement in strategic decision-making processes within the company. Thanks to the varied composition of the focus groups, diverse perspectives and information have been obtained. Every session lasted approximately 1.5 hours.

Highly interactive interviews were conducted to enhance collaborative knowledge sharing and discussion. The semi-structured design of the focus group discussions allows not only for flexibility and adaptability, but also it enables the exploration of unanticipated insights and emergent themes. According to Saunders, Lewis, & Thornhill (2016), this method has exploratory elements, that allow for discussion on areas that might not have been initially considered by the participants.

Given the sensitive nature of the topic and its potential impact on company strategy, the participants were assured anonymity to encourage open communication. The main objective of these interviews is to collect information for the development of an educational case study. By analyzing the adaptive strategy implemented by the organization, some theoretical frameworks and aspects can be highlighted even if the case does not totally correspond to the reality.

In addition to the primary data, multiple internal and supplementary external documents, literatures have been reviewed to further enhance understanding of the applied strategies by the company.

	Date	Position of interviewees
1.	2024. 03. 12	Head of Section Carlines, Product Leads, Product Managers
2.	2024. 03. 14	Head of Product Strategy, Product Manager, Product Planners
3.	2024. 03. 15	Head of Section Product Planning, Product Planners, Product Lead

Table 1: Interviews overview (Source: Own Figure)

3. Case study

The objective of the case study chosen for this dissertation is to examine the resources and steps taken by a well-known automotive company to navigate its way beyond the challenges generated by the semiconductor crisis. Professors can apply this case study during classes to showcase the ways in which the organization's decision-making and production planning were affected by chip shortage.

It presents a general overview of the automotive sector, covering its scale, economic significance, and the current trends as well as external factors that are affecting it. Both the relevance of semiconductors and the causes of the chip shortage will be analyzed in-depth. And lastly, it delves into the company's adaptive strategy based on focus group discussions drawing insights from industry experts / automotive employees.

3.1 Automotive industry significance, complexity

The automotive industry traces its origins back to the late 19th century, with pioneering individuals such as Ford, Daimler, Benz, Chrysler, and Dodge striving to establish a promising sector (Emmanuel, 2018). Even though it has a relatively short history compared to other sectors, the automotive industry holds exceptional significance due to its essential impact on the global economy. It is an important source of employment – approximately 5% of the global labor force is directly or indirectly employed in this industry. Another surprising fact is that the total turnover of the automotive industry is greater than the gross domestic product of France (International Labor Office, 2009). Moreover in 2020, it ranked among the largest industries worldwide, contributing approximately 3% to the global economic production (Cohen, 2021).

There are more than 500 million registered passenger cars worldwide and annually around 70 million vehicles are produced (Monye et al., 2023). Its influence extends across several areas including design, development, production, manufacturing, marketing, sales and aftersales. It is also relying heavily on linked supply chains such as oil, steel, plastics, and rubber moreover

it plays a crucial role in the development infrastructure including transportation system, roads, and fuel/charging stations.

Hence automotive companies expanding their operations globally, this industry has one of the most extensive and difficult-to-manage supply chains. High-degree globalization, technological advancements, and reduced trade costs have led to the increasing fragmentation of production. The different stages often occur in different factories spread out over the globe. While this has brought some significant gains in efficiency and productivity, on the other hand it has also made the production processes more vulnerable to disruptions.

Figure 1 demonstrates a well-established measure of supply chain length, indicating the number of production stages necessary to manufacture a product. A higher index signifies a longer supply chain, which introduces more uncontrollable factors such as longer lead time.

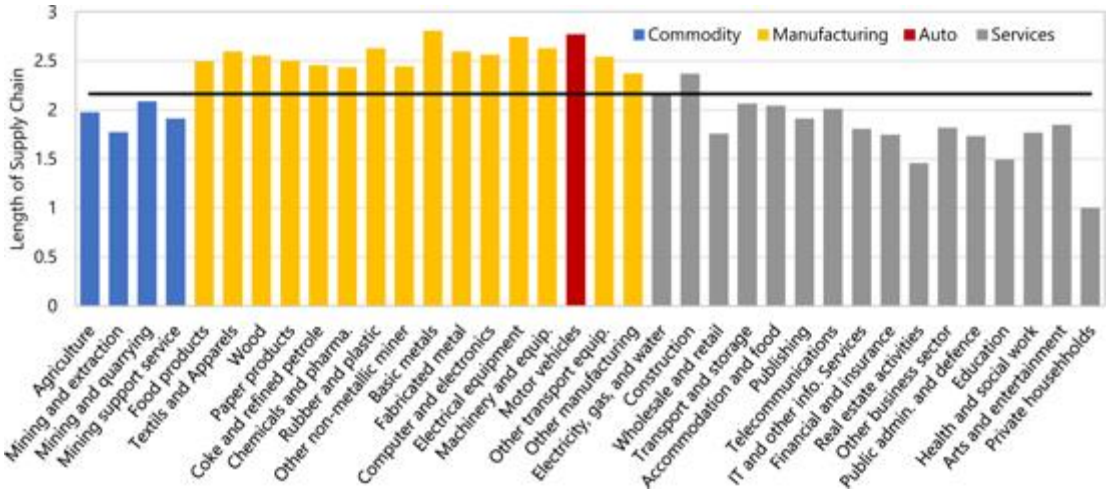

Figure 1: Length of Supply Chains (Source: OECD ICIO and IMF staff calculations)

As this research demonstrates, the automotive industry has the longest supply chain among all sectors in the economy as automotive supply chains consist of multiple tiers of suppliers, manufacturers, distributors, and service providers throughout the world (Boranova et al., 2022). A general vehicle can contain 15,000 - 25,000 components such as engines, steering wheels, windows that are produced either by other sectors or their own. Managing such an enormous line of materials and ensuring their integration means a significant logistical challenge for the automotive firms (Kowal, 2023).

Overall, considering these statistical data we can clearly see the significant potential of this industry. Nevertheless, they also underscore its riskiness as even minor disruptions in the supply chain can lead to severe consequences.

3.2 External factors, trends within the automotive sector

The global automotive industry is characterized by its continual adaptation to external shocks, emerging trends, and technologies. Over recent years it underwent various shifts and transitions due to influencing factors, which might come from either an external or internal environment (Lindner, 2016).

In 2020 the initial lockdown measures due to the Covid-19 pandemic significantly affected manufacturing, particularly within the automotive industry, which contributed to the overall decline in industrial production. This decrease in car manufacturing during the year further accelerated the ongoing gradual drop in global vehicle production.

The general economic slowdown, factory closures, workforce reductions and numerous other factors contributed to this production decline. Due to the global lockdowns and the stay-at-home mandates purchasing a new vehicle became one of the least priorities for consumers which resulted in a significant drop in the demand for new cars. On the other side, there was a surge in demand for consumer electronics like PCs, laptops, smartphones, and home devices due to remote work and lifestyle changes. Consequently, chipmakers redirected manufacturing capacity from automotive orders to meet this increased demand.

In 2017, as Figure 2 showcases, vehicle production in the world reached a peak with 97 million vehicles manufactured. However, in 2018-19, production dropped by around 6% due to stricter emission standards and lower global demand. With the added effect of the lockdowns in 2020, production declined by an additional 15% to 77 million vehicles (Boranova et al., 2022).

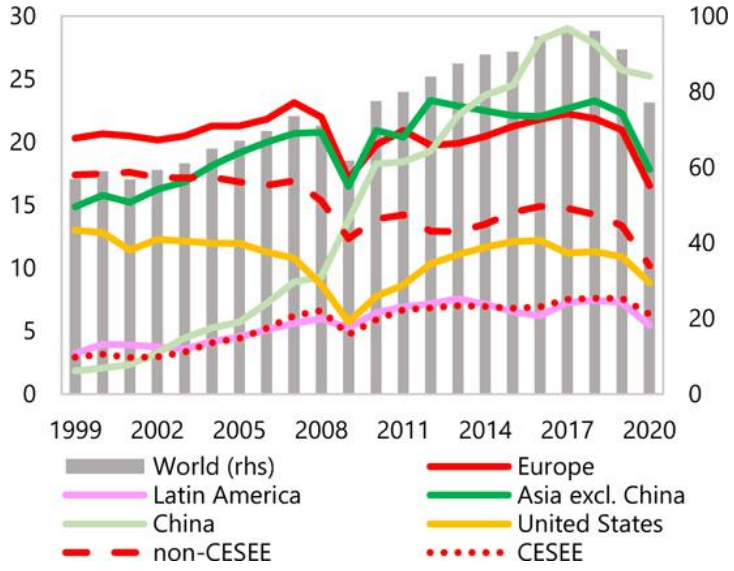

Figure 2: Vehicle Production: 1999-2020 (Source: OICA)

Besides the effect of Covid-19, numerous external factors have disrupted the automotive sector including rapid technological advancements, evolving environmental regulations, and changing consumer preferences. All of these trends began earlier and have accelerated following the pandemic.

The automotive industry is undergoing a transformative shift driven by cutting-edge technological advancements. Particularly the integration of Artificial Intelligence (AI), the Internet of Things (IoT), and data analytics are in the spotlight. These innovations are not only reshaping the competitive landscape but also forcing OEMs to invest significantly in research and development (R&D).

Furthermore, stricter global regulations imposed by governments are driving a shift towards electric vehicles. Several European countries are banning the sale of new diesel cars and offering tax incentives for electric vehicle adoption to mitigate air pollution. These political initiatives, such as policies mandating zero-emission vehicles compel automakers to produce vehicles that are more fuel-efficient and have lower emissions. To meet these regulatory requirements, OEMs have to consider significant operational adjustments and financial investments, which affect production costs and profitability (Hirani, 2023).

Moreover, the sector also faces disruptions due to changing consumer behaviors and preferences, particularly towards digitalization, automation as well as for sustainable solutions. Economic factors such as increasing fuel prices, leading consumers towards smaller, more fuel-efficient vehicle purchases. These trends influence both purchasing decisions from the customer side and production strategies from an organizational perspective, leading to changes in product offerings and market dynamics.

"Electric vehicles and autonomous driving or other higher functions, these developments have really happened cumulatively. (...) For the car industry, this increase in functions, which has only happened in the last few years, has been faster than usual. The car industry is normally prepared for a way in which things are introduced bit by bit, it takes time, the cycles are very long. So, it really does take years to introduce certain features. But in the last few years, so many features have developed so quickly that it was simply difficult to predict, even for the automotive industry." Industry Expert (Ziegler, 2023)

The two figures from Bloomberg (Figure 3) can illustrate that electric vehicle (EV) sales continued to increase in 2020 while there was a significant decline in internal combustion

engine (ICE) car sales. This resulted in a remarkable growth in the share of EV sales compared to pre-pandemic levels in Europe.

Figure 3: Car Sales by Fuel Type: Europe 5. (Source: Bloomberg)

The transition towards EVs, hybrids, plug-in-hybrids and (partly) autonomous vehicles has led to increased demand for critical components like batteries. Hence these cars are equipped with more advanced features and technologies that require sophisticated systems-on-chip designs, the manufacturers experience a heavy reliance on semiconductors (Supply Chain Brain, 2023).

3.3 Supply chain disruptions, chip shortage

While the automotive sector demonstrated adaptability during the pandemic with a recovery in production, severe supply chain disruptions emerged in the next year. Delays in delivery, minimum 12 months' waiting times, missing popular features, unrealistically high secondhand prices… these were the experiences of those who planned to buy a new car in 2021 because of only one component, a microchip (Boranova et al., 2022).

3.3.1 Importance of Semiconductors within the automotive industry

A microchip, also known as integrated circuit (IC), is a small (averaging just 20 nanometers) semiconductor device containing computer circuits primarily used for logic or memory functions in electronic devices. Although these chip transistors are about 10,000 times smaller than a human hair, they are the brain in modern electronics. Collaborating with the ECU (electronic control unit), chips play a crucial role in controlling every system in the vehicle including the electrical system, the powertrain, safety and comfort systems, and the infotainment and connectivity systems (Ziegler, 2023).

On average, between 1,400-1,500 chips are used for a modern car, with some models requiring up to 3,000 (Applied Energy System 2023). The lack of a specialized chip posed significant

challenges for automotive manufacturers such as sacrificing various functions in cars, for example interior lighting, seat control, blind spot detection, wireless charging system, air conditioning, keyless access, controlling airbags and assistance system ect. (Köllner, 2022).

Despite the fact that most people only connect chips to computers and smartphones, the chips shortage trends started in the automobile industry, which gradually attacked other industries.

As we can see from this McKinsey study (Figure 4), not only in the automotive industry but also in several others, the demand for semiconductors in 2020 and 2021 exceeded pre-pandemic forecast. While consumer electronics experienced the most significant deviation from forecasts, the automotive industry suffered the most severe shortage due to its high complexity. It is challenging to improve the cycle times due to the complicated, long process of designing, manufacturing, testing, and delivering a product. As a result, automotive OEMs and Tier 1 suppliers found themselves increasingly competing with companies in other industries for chips (McKinsey, 2022).

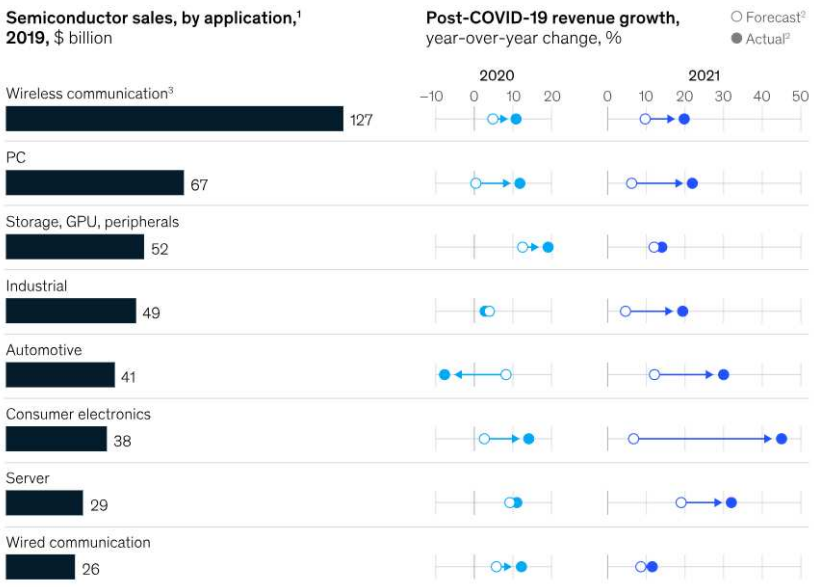

Figure 4: Overall demand for semiconductors (Source: McKinsey)

Another reason for the semiconductor market's highly competitive nature was the limited number of players such as TSMC, Nvidia, Intel, and Samsung, who dominate the market (Schönfeld, 2022). The geographical concentration of chips in Asia further limited the flexibility especially for the European car manufacturers. According to a recent estimate nearly three-quarters of global semiconductor manufacturing capacity is located in four countries in Asia. Especially the most cutting-edge chips' capacity is limited, as also Figure 5 showcases below (World Economic Forum, 2021).

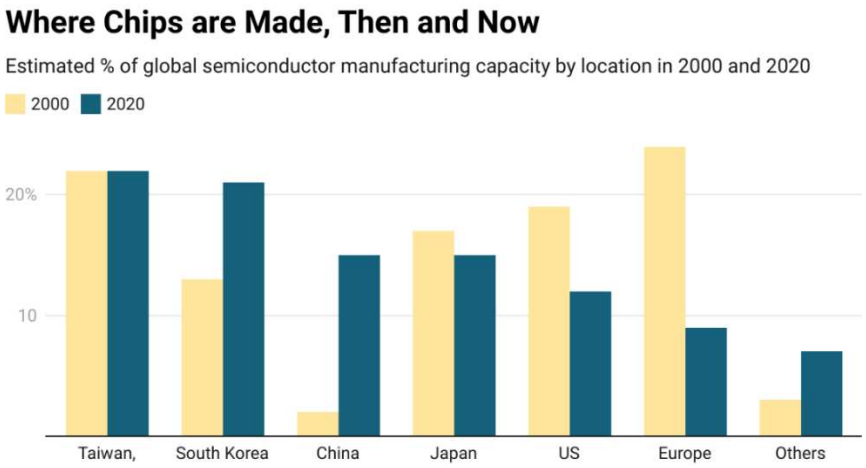

Figure 5: Estimated % of global semiconductor manufacturing capacity. (Source: BCG, SIA)

3.3.2 Chip shortage

As indicated above, in spring 2021, the automotive industry was one of the hardest-hit sectors by the chip shortage. Despite increasing demand for vehicles, the market was unprepared for a rapid recovery. The industry players faced disruptions which forced them to temporarily reduce/close production lines or eliminate popular features like heated seats from their offerings.

Consequently, over 11 million vehicles were removed from production (Statista, 2023), while manufacturing lead times skyrocketed to 10-12 months. That was a significant increase compared to the normal procedure which takes approximately 3-4 months (Straughan, 2023). This crisis is considered an extremely exceptional case as such consequences have never occurred in the industry before.

One of the reasons is the automotive landscape's unique characteristics for example, many OEMs and Tier 1 suppliers have a 'just-in-time' (JIT) production strategy, ordering semiconductors and vehicle components as close as possible to production. One of the benefits of this method is the ability to avoid having either too little or too many inventories. This suggests that components need to be delivered exactly when needed for immediate use in the assembly process. A single supply delay in delivery could halt the entire manufacturing.

When car sales dropped in the early 2020s, during Covid time, OEMs and Tier 1 suppliers decreased their chip orders. It left the dealerships with minimal inventory when demand started to recover. Usually, the JIT strategy offers numerous benefits, however in this situation the manufacturers that did not follow JIT ordering were in a better position due to their secured inventory capacities.

Another hindering factor comes from the transportation of semiconductors. These components are often transported by air however, transport costs have risen significantly while the number of available shipments has decreased (Xilling Wu et al., 2021).

The Russia-Ukraine war has introduced further significant uncertainties and challenges. Russia plays a crucial role in the semiconductor industry as the country is supplying 25-30% of the world's palladium, which is a rare metal essential for semiconductor production. Ukraine, as a key provider of purified neon gas, also is a critical player in the chip manufacturing process, contributing 25-35% of the global supply. Given the European Union's strong dependence on both nations for EV batteries and green technologies, the conflict between these countries has significantly disrupted the car industry (Reuters, 2022).

In the following section, we'll take a deep dive into how a particular OEM managed the strategic adaptation to the chip crisis more rapidly and effectively than its competitors. Their strategy will be analyzed, which helped the company not only to survive but to achieve outstanding sales results and higher market shares.

3.4 Company overview, standard strategy

The company examined in this section will be anonymized to protect sensitive and confidential information. Therefore, the following overview provides a generalized summary of the firm's supply chain operations, product planning and adaptive strategies without revealing its identity.

The company where I have interviewed the teams from the Product department is a significant player in the automotive sector, outstanding due to its flexibility in responding to market dynamics. Within its Product department of the European Headquarter, teams are responsible for strategic forecasting through market research to align vehicle production with evolving consumer preferences in the future and support the current product line in potential changes. It involves monitoring general market trends, competitors' performance, consumer insights and additionally collaborating with the global supply chain management team to ensure operational efficiency throughout the entire process.

The decision-making process at the company is characterized by agility, with a relatively rapid top-down approach. Even though they are a well-established multinational corporation with a long history, they encourage a startup mindset where new ideas are welcomed and supported. "*For us every day is a new day, and every project is unique and flexible, this is a part of our DNA."*

They believe that taking each day as it comes can foster a culture that allows them to adapt quickly to new challenges and opportunities. *"Every project is different… the strategy is not having a fix strategy."* By avoiding rigid commitments to specific methodologies or strategies, the company can navigate uncertainties more effectively.

In terms of production strategy, the company tailors its approach to each region and to specific circumstances. Instead of treating the European markets as homogenic entities, they adapt their strategy tailored to the different market needs and trends. *"They have different customers and local government strategies".* During production disruptions, their philosophy is not to rely on predetermined crisis strategies, they rather approach each situation differently.

Inspired by Toyota's efficiency principles, production emphasizes simplification of the product line, and avoiding unnecessary complexity. The production process in European factories remains traditional, operating on a make-to-stock (MTS) basis. Applying this strategy means that the products pushed according to forecasts. One of the main benefits of this production strategy is the ability to produce inventory based on the anticipated demand to minimize their inventory. However, to take advantage of this strategy, the forecast has to be accurate, otherwise the company could suffer a lot.

A key aspect of the company's strategy is its significant reliance on internal suppliers, which creates a tightly interlinked network of processes with fast and transparent communication between the entities. Furthermore, the company benefits from expertise in low-level semiconductors.

3.5 Adaptive strategy during chip crisis

"How do you avoid shutting down factories, continue selling cars, and satisfy customers? How do you prevent closing networks with dealers and suppliers, ensuring that the existing system operates at a level that won't harm the business?" Not only the product team, but the whole company was trying to find answers to these crucial questions.

Due to the war for the chips and increased customer demand for the vehicles, the company faced the critical challenge of keeping operations running smoothly, avoiding factory shutdowns while maintaining relationships with dealers and suppliers and keeping customers satisfied. *"You cannot just turn on the lights in an automotive factory and continue manufacturing cars."* In the following section, their strategy will be analyzed, showcasing a clear overview of how the company was able to survive the chip shortage.

3.5.1 Vertical Integration

A cornerstone of the company's resources in mitigating the impact of the disruption was its vertical integration. Unlike many competitors, this company maintains ownership and control over various critical elements of its supply chain, including semiconductor and steel production, transportation vehicles, port locations, factories, as well as manufacturing machines. *"It is almost owned by us"*.

Thanks to vertical integration, which is much more appreciated today's ever evolving environment, the OEM can secure a more stable supply of chips by reducing the reliance on third-party providers and mitigating risks associated with external disruptions. Being independent is a crucial part of the organization's culture. *"We try to minimize the reliance on any external organizations"*. It also enables the company to have a greater influence over the production process, ensuring adherence to quality standards and specifications tailored to its unique requirements.

By streamlining the journey of raw materials, components, and finished products throughout the supply chain, the firm is able to implement agile production adjustments in response to changing demand dynamics or supply constraints. This can lead to optimized manufacturing efficiency and resource utilization.

Overall, this unique and comprehensive vertical integration afforded the company greater autonomy and flexibility in managing its supply chain operations. By having control over crucial aspects of the supply chain, the company could optimize costs, maintain financial stability, ensure quality standards, and strategically allocate resources, thereby delivering products to market more reliably and minimizing disruptions during the crisis.

3.5.2 Prioritization

The company's ability to effectively manage the chip shortage crisis was not only due to its vertical integration and close supplier relationships but also relied heavily on strategic chip allocation through prioritization. Understanding the challenges coming from the shortage of semiconductor chips, the organization strategically focused on prioritizing the manufacturing of its top-selling and most popular vehicle models. *"It made us think differently"* highlighted by one of the Product Managers. This strategy aimed to ensure that production efforts were aligned with customer demand and profit margins.

By strategically allocating semiconductor chips to vehicles with the highest demand and potential for profitability, while possibly reducing production or delaying less popular models, the company was able to maximize the effective utilization of the limited semiconductor resources. *"We were focusing on keep producing whatever gives us money and keep reducing the lower profit cars."*

Another approach was simplifying or reducing certain features in vehicles to reduce their dependency on chips. *"Sometimes the solution can be quite simple. For instance, when faced with a shortage of keys, instead of providing two keys, we offer just one to the customer. This allows us to effectively double our supply"* mentioned by one of the product team leaders. While this meant customers had to wait for the additional key, they were still able to drive away with their new car. At the end, customers were often forced to give up a few nice to have features, which would have required more chips. However considering the situation that they had to wait months or even years for a new car at other dealerships, many chose this company offering a lower trim car.

As a result, certain vehicle models or market segments were affected more significantly by the chip shortage. Smaller and more affordable car models experienced more severe shortages as the OEM focused on maximizing profitability in its product lineup. *"Our A, B segment cars has a lower profit margin than the C, D products which led us to focus on the later ones."*

3.5.3 Task Force Team

Another proactive initiative was establishing an emergency Task Force Team (TFT). This cross-functional team was working on comprehensive and effective strategies against the crisis. Its members were gathered from various departments, including procurement, manufacturing, market intelligence and other relevant areas.

It underscored the company's commitment to collaborative problem-solving and agile decision-making. Through regular meetings and continuous information sharing, the TFT facilitated the exchange of real-time insights and potential ideas. "*We were trying to not only react to changes but anticipate them."*

Moreover, the TFT served as a catalyst for innovation within the organization. Encouraging a culture of experimentation and creative problem-solving, the experts were empowered to explore new approaches and solutions. *"We were trying to do something that we have never tried."*

Furthermore, the TFT played a crucial role in building resilience within the organization. By proactively assessing potential risks and developing contingency plans, the team helped the company anticipate the challenges in the semiconductor supply chain. Through proactive risk management, the TFT strengthened the company's ability to survive external shocks and navigate unpredictably changing circumstances with confidence. After the crisis, the TFT was disbanded, and the employees returned to their regular roles and responsibilities. *"Everybody is giving their perspective in the real-time reporting to management in a fast way to be able to adjust the strategy and when the panic is gone, they go back to their teams."*

3.6 Impact of the strategy

While many competitors struggled to meet demand, some even failing to deliver cars, this OEM emerged as one of the clear winners. As many customers had to face long wait times from other brands, they have chosen the company for quicker access to new cars.

With the implementation of the new strategy during the chip shortage, the OEM's market share has significantly increased. Overall, this strategy has yielded positive results for the organization with peak demand for its models, and outstanding sales performance.

Despite not being considered as a premium brand, the company attracted many customers away from its high-end competitors. By gaining previously untapped customer segments, the company expanded its customer base and increased market penetration. Moreover, the strategy not only attracted new customers but also increased visibility and positive brand perception from existing customers.

The semiconductor crisis served as a valuable learning experience and learning opportunity for the product team. It highlighted the importance of flexibility and agility in navigating unexpected challenges. Additionally, the crisis underscored the risks associated with overreliance on external suppliers. These lessons have enabled the company to better anticipate and respond to future disruptions, ensuring its continued success in the ever-evolving automotive landscape.

3.7 Post-Crisis Strategy

As recently the chip shortage comes to an end and the automotive market is getting stabilized, the revenue and the market share of the company are plateauing. While during the crisis this strategy was proven to be very effective, now the company needs to figure out how to stay

competitive in a more stable market. *"Now things are back to normal, competitors are catching up and we have to change our mindset again."* says a company representative.

Nevertheless, the product team is trying to remain proactive in preparing for potential future disruptions in the automotive industry. They've established a dedicated task force focusing on crisis management. The members are responsible for monitoring the market, informing management about some changes, and finding alternative solutions to ensure that the company stays ready to adjust to shifting market conditions.

4. Literature background

In the following chapter, theoretical frameworks in Agile Supply Chain Management, Vertical Integration Management, Resource Based Theory, Dynamic Capabilities and Strategic responses to crisis will be analyzed. The aim is to establish a theoretical foundation for understanding how companies address challenges arising from the external environment when formulating their company strategy. These frameworks will help to make connections and predictions with the case study presented before.

4.1 Agile Supply Chain Management

Supply chain management can be defined as, *"the systems approach to managing the entire flow of information, materials and services from the raw materials suppliers through factories and warehouses to the end customer"* (Leenders and Fearon, 1997). Its primary goal is to optimize operational efficiency, reduce costs, improve profitability, and enhance customer satisfaction by streamlining processes, minimizing inventory, and fostering collaboration among supply chain partners (Cooper et al., 1997). Supply chain links suppliers and customers from the extraction of raw materials until the product reaches the ultimate end user. According to Tang and Qian (2008), the industry supply chain extends from raw material producers to the companies that assemble the most advanced electrical and computing technology.

This complex network involves multiple entities including suppliers (Tier 1 - 3), original equipment manufacturers, distribution centers, dealers, and customers. A supply chain therefore comprises a physical element as well as the information element.

Organizations may reduce risks, capitalize on new opportunities, and react faster to changes in demand by efficiently managing the flow of information and materials (Hugo et al., 2004).

According to Lambert and Cooper (2000) several variables, such as the accessibility of raw materials, the quantity of suppliers available, and the complexity of the product have an impact on supply chain management. Growing complexity of the product lines and interconnection of the existing networks can lead to a more unstable and volatile manufacturing system.

Since industries, particularly automotive sector, have recognized the difficulties posed by complex supply chains, they are trying to simplify the process and they aim to streamline their supply chain operations by reducing diversification, which allows for greater resilience and control in the face of volatility (Mizgier et al., 2013).

Given the complexity and dynamic nature of this supply chain, agility emerges as an essential concept in supply chain management, reflecting the need for responsiveness and flexibility in today's ever-evolving market (Christopher, 2000). In this context, agility refers to the ability of the supply chain and its members to quickly align operations with dynamic customer requirements and proactively adapt to changing conditions, which are very common in the automotive landscape. This adaptability allows businesses to seize emerging opportunities and maintain resilience and a competitive advantage in volatile markets. Agility is all about customer responsiveness, people and information, cooperation within and between firms and fitting a company for change. To be truly agile, a supply chain must possess a number of distinguishing characteristics which include market sensitivity, process integration, and networking (Tang and Qian, 2008).

4.2 Vertical integration in supply chain management

Since the last decade supply chain integration, described as the realignment of firms' operating structures (Chen, 2009), has gained particular interest from both industry professionals and researchers (J.Arias, 2022). This strategic approach has disrupted traditional channels of distribution and eliminated intermediary markets, forcing companies to view supply chain management as an integrated system to stay competitive in the market. Vertical integration refers to a development of network including elements of supply chain, which are the customers, suppliers, and the organization (Nadia, 2018). This is a process of expanding a company's ownership over different stages of the manufacturing and distributing process. By having this comprehensive control firms can streamline operations from raw material to product delivery to end customers (Guan, 2012).

This integration of the supply chain is crucial for firms to effectively control the flow of tangible as well as intangible materials and meet the needs not only of the market, but also of all the suppliers (Stevens, 1989). Especially in the automotive sector this integration is particularly essential, as the firms need to be resilient to external shocks and have the ability to quickly adapt to changing environments (Guan, 2012).

Adopting flexible communication facilitates the vertical integration of production process-relevant data, hence bridging the gap between business and technical levels (Gerber, 2012). Furthermore, cooperation between independent organizations in supply chains has gained significant attention improving overall success. The mutual benefits of the symbiotic relationship among suppliers and retailers in vertically integrated supply chains are recognized by many. This underscores overall the importance of collaborative efforts enhancing adaptability and resilience against shocks (Lummus et al., 2001).

In terms of benefits, this strategic approach offers several advantages, such as improved shorter lead times thanks to the fast, transparent communication, ability to capture more value cost savings through economies of scale, quality control, streamlined coordination, and enhanced responsiveness to customer demand (Holweg et al., 2019).

Furthermore, through vertical integration organizations can also enhance supply chain visibility and traceability, which helps them to track and manage their resources and potential inventory more effectively. They can mitigate the risk associated with external disruptions, such as semiconductor shortages or production delays. This can lead to higher market competitiveness and profitability in the long term (Gereffi et al., 2005, Shekarian, 2020).

4.3 Resource-Based View Theory

The Resource-Based Theory (RBT) proposed by Jay Barney in 1991 provides a profound perspective on a strategic management framework. It suggests a firm's sustainable competitive advantage arises from its unique combination of resources and capabilities rather than external factors when the market environment is rapidly changing (Barney, 1991). It is an advantage an organization has over competitors, gained by offering consumers greater value, either by having lower prices or by providing greater benefits and service that justifies higher prices.

The ability of a company to maintain its competitive advantage relies on the degree of difficulty associated with imitating its resources and capabilities (Dierickx & Cool, 1989). This typically

can be obtained when existing and potential competitors lack the ability to replicate the assets of the firm (Amit & Schoemaker, 1993).

The approach recognizes that some resources can be traded or accessed with ease, while others need a substantial amount of time and money to develop. It makes some factors of the supply chain management less elastic and flexible. The supply chain contains a wide range of resources, including tangible assets (e.g., physical infrastructure, technology), intangible assets (e.g., brand reputation, intellectual property), and human capital (e.g., skilled workforce, expertise). Furthermore, capabilities such as effective supplier relationships, efficient logistics and innovative product development processes are crucial for a competitive edge in supply chain management (Dierick & Cool, 1989).

Barney (1995) also introduced the VRIO (Valuable, Rare, Inimitable, Organization) framework which can be used as an analytical tool to evaluate the resources of competitive advantage and determine which of these competitive advantages are considered to be sustainable. According to the theory, a firm's resources must have four attributes, in order to increase the firm's competitive advantage in the long-term period: value, rarity, imitability and organization.

The concept of having value refers to the firm to seize opportunities or mitigate threats with the resource, in order to maximize the firm's efficiency and effectiveness. Rarity, as a second requirement assesses whether that resource or capability is uncommon among competitors, determining its uniqueness and scarcity. As a third attribute, imitability refers to the temporary competitive advantage by having a resource difficult or expensive to replicate. Lastly, organization refers to the firm's capacity to effectively utilize the resource to implement strategies that generates a competitive advantage. This includes overcoming regulatory barriers or other obstacles that may limit the firm's ability to fully utilize its resources and capabilities (Barney & Wright, 1998).

4.4 Dynamic Capabilities

The Resource-Based Theory was further extended to Dynamic capabilities (DC) to address the need for adaptability in rapidly changing environments and not only in a static nature (Teece et al., 1997).

Similar to RBT, the dynamic capabilities framework explains how firms achieve and sustain competitive advantage over an extended period (Einsenhardt & Martin, 2000; Tecce et al., 1997). DCs are defined as "the firm's ability to integrate, build, and reconfigure internal and

external competencies to address rapidly changing environments" (Teece et al., 1997, p. 516). In 2010, Barreto proposed a formal definition of dynamic capabilities: “dynamic capability is the firm’s potential to systematically solve problems, formed by its propensity to sense opportunities and threats, to make timely and market-oriented decisions, and to change its resource base” (Barreto p.271, 2010). It aims to ensure organizations adapt to and navigate changes in their business environments to establish lasting competitive advantage (Teece, 2007).

Unlike static capabilities, which focus on optimizing existing processes and routines, dynamic capabilities enable companies to continuously reconfigure and innovate their organizational skills, internal and external resources, and functional competencies to meet evolving market demands and seize new opportunities while also being more resilient when shocks require rapid alignment or expansion (Amit & Schoemaker, 1993; Teece et al. 1997).

Dynamic capabilities are broken into three main processes: sensing, seizing, and transforming. Sensing is the process of quickly identifying and evaluating opportunities, risks and developments in the external environment, such as shifts in customer preferences, technological advancements, or emerging market trends. This can be achieved for example through warning systems and risk management departments that give a firm more time to react to external shocks (Teece 2007).

Once opportunities are identified, firms must be able to mobilize them effectively to seize those strategic opportunities. Seizing capabilities involves making strategic decisions and taking swift action to exploit opportunities, whether through product innovation, strategic partnerships, or market entry strategies. This requires agility, decisiveness, and resource allocation aligned with strategic priorities.

The third process involves the ability to transform key objectives in response to shifting external circumstances. This may entail restructuring processes, reallocating resources, or developing new organizational routines as well as ensuring a firm’s continuous strategic renewal. Strong reconfiguring capabilities enable organizations to remain flexible and resilient, and to adjust their strategies in real time (Teece, et al. 1998).

Overall, this framework focuses on deciding how to do right things, rather than how to do something right. It provides a structured, comprehensive approach to understand how these capabilities contribute to sustained competitive advantage and how organizations can maintain it during unpredictable periods (Barreto, 2010).

4.5 Strategic responses to crisis

Based on an overview of papers and articles published in the journals of the Strategic Management Society, there are four different ways how organizations can react to crisis: Retrenchment, Persevering, Innovating and Exit (Wenzel et al., 2020).

Retrenchment refers to "reduction in costs, assets, products, product lines and overhead" (Pearce & Robbins, 1993). Some argue that these measures can provide a solid basis for strategic renewal as it improves the focus on existing activities by increasing transparency and decreasing complexity (Pearce & Robbins, 1994). However other studies indicate that reducing business scope can lead to net loss, especially when synergy effects are destructed which can hinder economies of scale in the long term (De Figueiredo et al., 2019).

As another alternative Persevering focuses on maintaining the status quo and mitigating the adverse impact of the crisis (Wenzel, 2015). According to several studies, during uncertain times rapid and frequent strategic changes undermine the effectiveness of strategic renewal (Stieglitz et al. 2016). However, it is important to mention that this response depends on the availability of internal and external resources, therefore it is debatable that Persevering can be challenging over a longer period of time.

Some authors argue that during crisis time Innovating can be particularly effective which involves broadening an organization's scope of business activities and exploring new alternatives. By expanding the business into other sectors and reflecting on new business approaches, companies can adapt faster to the new environment (Reymen at al. 2015). However, the success of this response depends on managers' ability to adapt decision-making processes and utilize resources effectively to enable strategic change in uncertain circumstances (Wenzel, 2020).

The fourth response type – Exit – is unavoidable when the other strategies fail (Dai et al., 2017). This proactive approach is not necessarily imposed by adverse environments, it can serve as a basis for strategic renewal by freeing up some resources for new measures (Carnahan, 2017). Therefore, Exit is not referring to the end of opportunities, but offering a great opportunity to survive the challenging crisis time. However, it is not costless and potentially leaves a stigma of "business failure" (Xia et al., 2016).

5. Teaching Notes

The following chapter will help professors understand how to apply this business case in the context of a class utilizing the strategic management techniques given in a real company situation. The section contains general synopsis of the case study, teaching objectives, potential questions for student assignments with proposed solutions including a comprehensive analysis and discussion. Given all these materials students should be able to draw connections between theoretical concepts and practical situations elaborated in the previous chapters. In this case, analyze how the automotive company reacted to the semiconductor shortage and how they adapted their strategic plan in order to overcome this crisis.

It is important to note that the solutions are generic, which means that both professors and students may have different points of views and opinions on the concepts and may approach the case from different perspectives. Additionally, since this case study was written between February and May of 2024, there might be some changes in the company's strategy and within the industry, which need to be taken into consideration.

5.1 Teaching Objective and Audience

The primary purpose of this teaching note is to help students to better understand how companies adapted their strategies and decision-making processes in response to evolving markets conditions during the severe economic crisis like the semiconductor crisis in the recent years. Students will be able to apply various theoretical frameworks to real-world scenarios in order to solve the case, while also being encouraged to explore additional concepts from their own perspectives. Students should be able to identify the threats and opportunities of the complex situation created by an external factor - in this case the chip shortage -, the capabilities that the company has and suggest adaptive strategies for the organization.

Suggestions of questions for assignment and potential answers will be shared, nevertheless, it is advisable for students to have access to the case and to the proposed questions to conduct their own analysis and compare the findings. This case is based on a real-life example of an automotive company. As a decision-based case, students are asked to play the role of the product management or the supply chain management team of the company, analyze the provided situation, and formulate production strategy recommendations based on analysis and critical thinking.

The target audience of this case study are students pursuing either bachelor's or master's degree in Business, Management or Economics as well as those enrolled in various management programs with a focus on Strategic Management, Strategy Consulting, and Supply Chain Management. No specific background or previous work experience is required but recommended for a better understanding of the practical aspects of the case. Furthermore, it is necessary to have a solid knowledge of the basic strategic concepts and principles. For this reason, first the professor should give the underlying theoretical frameworks to the students, and then present the case and the questions. These assignments can be discussed either individually or even in a group work.

5.2 Assignment Questions

- Q1: Analyze the internal strengths and weaknesses as well as the external threats and opportunities of the organization.
- Q2: What internal resources and capabilities have the company embraced of their strategy to react rapidly to the semiconductor shortage?
    a. Analyze these resources using the VRIO framework.
    b. Asses the company's dynamic capabilities.
- Q3: What are the advantages and disadvantages of the company's vertical integration strategy?
- Q4: Considering the responses of Retrenchment, Persevering, Innovating and Exit which type of strategy would you recommend to the company to survive the chip shortage?

5.3 Analysis and Discussion

In this section the in-depth analysis of the case and the potential answers for the assignment questions will be introduced. It is important to mention that the following answers are not the only way to approach these questions.

Q1: Strengths, Weaknesses, Opportunities, Threats

The SWOT (Strengths, Weaknesses, Opportunities, Threats) framework is considered one of the most widely used tools for strategic planning (Glaister & Falshaw, 1999). Hence it is an effective and exhaustive tool to analyze the internal strengths and weaknesses as well as the external threats and opportunities of the organization, it can be applied to teaching cases such this case study.

The students are expected to identify and structure the information and factors related to the company. After this assignment they will better understand the strategic fit of the business with its external environment as a starting point. The main objective is to evaluate the company's competitive position and to help develop a strategic plan during a crisis time. It will also help to gain an extensive overview of the company's resources and capabilities and their potential strategic applications during crisis time.

STRENGTHS	**WEAKNESSES**
• Strong reputation, global presence • Supplier relationships • Vertical integration • Agile and flexible culture • Customer centric approach • Risk management practices • Simplified product line • Operational efficiency	• Supply chain vulnerability • Great exposure to disruptions • Over-reliance on internal suppliers • Impact on production capacity • Delays, eliminated features • Financial implications • Just in time approach, make to stock • Growing demand for chips (EV)
OPPORTUNITIES	**THREATS**
• Growing demand for EV • Post-Covid peak in demand for cars • Customer dissatisfaction at the competitors • Prioritization • Research for accurate forecast • Offer lower trim vehicles	• War for the chips, semiconductor domination by Asia • High level of uncertainty • Complexity of this industry • Strict governmental regulation • Shifting customer preferences • Rapid technological improvements • Rising transportation costs

Table 2: SWOT Analysis of the company (Source: Own Figure)

Strengths: The company was able to establish a great reputation coupled with an extensive global presence. These factors provided a solid foundation for navigating the challenges of the semiconductor crisis. The strong relationships with suppliers, the transparent communication and its vertically integrated supply chain, including semiconductor production, steel production, transportation and manufacturing facilities enabled significant control over the production process. By having ownership over key components of the supply chain, the company is more resilient to external disruptions. Its agile and flexible organizational culture encouraged by a

startup mindset enabled rapid reaction to evolving market dynamics. The customer-centric, proactive practices with a commitment for continuous improvement and other crisis management approaches such as the Task Force Team also contributed to the organizational success. Additionally, by simplifying their product lines and the processes they can avoid unnecessary complexity and increase efficiency.

Weaknesses: As for the weaknesses, the organization faces vulnerabilities in its supply chain. As this is an automotive company, it has fragmented production and a long, extensive supply chain. Many critical components and materials depend on external factors, where the company has no control, additionally all the operations are highly exposed to numerous disruptions. Although thanks to its vertical integration it has control over certain aspects, it can lead to over-reliance issues. Quality issues or capacity constraints can ripple through the manufacturing process and can lead to delays in product delivery, eliminated features, lost sales opportunities and damaged customer satisfaction. Moreover, increased costs and production inefficiencies can lead to lower profitability. The company follows JIT and MTS mentalities requiring accurate forecast which is challenging during uncertainty. As the company extended its EV product lines, it has a significantly higher demand for semiconductor chips.

Opportunities: From an external perspective the post-pandemic recovery and the increasing popularity of electric vehicles offer a great opportunity for the company to profit from these market trends. Another big opportunity is coming from the competitors' failure to deliver cars on time, which led to dissatisfaction, and the customers explored other brands. The company gained market share and the brand is now more attractive to the customers who were loyal until the chip shortage. In the future it is a great opportunity to keep this extended customer base even if they are coming from a premium brand. Implementing strategic chip allocation and prioritization can enable the company to optimize resources and focus only on high-demand cars and value-added features. This not only maximizes operational efficiency but also presents a promising opportunity to continue allocating resources effectively in the future. This can help the company to avoid unnecessary expenses on underperforming models. Conducting several researches about customer preferences enables the firm to forecast the demand for specific models and features more accurately and identify high-demand areas. Additionally, by putting emphasis on lower trim cars with only the most popular must-to-have features the company can save numerous chips for other vehicles.

Threats: However, on the other side intense competition for the chips presents a significant threat for all industry players. The fact that the semiconductor market is dominated by Asia,

might pose challenges for the European Headquarter. Although the analyzed company has some advantage thanks to its better supplier relationships, supply chain disruptions still occurred. The high level of uncertainty mainly due to the Ukraine-Russia war and market volatility within the industry pose difficulties in effectively adapting to changes. Frequent regulatory changes, rapid technological advancements and shifting consumer preferences make this industry very complex. Additionally, the rising transportation costs were also hindering the process. Overall, these factors make strategic planning challenging.

Q2 / a: Evaluating the resources of competitive advantage (VRIO analyzes)

In this part the internal resources and capabilities of the company will be analyzed. The overview of the internal resources based on the Resource-Based Theory will be followed by the VRIO analyzes which can determine which of these sources of competitive advantage can be sustainable. The company was able to create a unique combination of resources including tangible assets, intangible assets, and human capital.

The vertical integration strategy of the supply chain components such as semiconductor, steel production facilities, transportation vehicles, port location and machines are considered one of the key internal resources of the company which helped to navigate through the chip shortage. These physical assets, technology and human capital are owned by the firm which enabled it to have a more extended control over the entire supply chain mitigating the risk of supply chain disruptions.

Strategic prioritization plays a significant role as another significant resource which allowed the company to efficiently optimize the limited semiconductors by allocating them for the high-demand vehicles and popular features. Thanks to this strategy the company was able to maintain operational effectiveness and ensure the timely delivery for the overwhelming majority of its product lineup.

The Task Force Team resource of the company is a cross-functional team, it played a crucial role in creating competitive advantage during the crisis. By proactively monitoring market changes, assessing risk and developing contingency plan the company is able to forecast trends, and respond swiftly to external shocks.

The agile organizational culture also contributed to the success of the company. Its startup mentality empowers employees to propose innovative solutions emphasizing adaptability and freedom of thought which are crucial during crisis time, facilitating rapid decision-making and

responsiveness. The fact that they tailor every strategy to specific circumstances, and different markets and not treat the European market as a homogeneous entity, also strengthens a more flexible reaction.

Close Supplier relationship with transparent and fast communication creates a tightly interlinked network of processes. Not only the physical assets are flowing smoothly, but also the information sharing is very effective across the components.

Lastly, the human capital, including a skilled workforce, technical expertise in many areas served also as a key resource of the company. The extended network from several parts of the world also enabled the company to have a broader perspective about the global market dynamics.

Through a VRIO analysis of the internal resources we will be able to identify some sources of competitive advantages that provide long-term sustainability. Table 3 illustrates the overview of the attributes. If some of these four attributes – value, rarity, imitability and organization – is missing it means that it is a temporary competitive advantage, if all of them are valid to a specific internal resource that means that the company has a sustained competitive advantage.

	V	**R**	**I**	**O**
	Valuable	Rare	Imitable	Organization
Vertical integration	✓	✓	✓	✓
Strategic prioritization	✓	✓	✗	✓
Task Force Team	✓	✓	✗	✓
Agile organizational culture	✓	✗	✗	✓
Close Supplier relationship	✓	✗	✗	✓
Human capital	✓	✗	✗	✓

Table 3: VRIO analysis (Source: Own Figure)

As Table 3 illustrates, we can conclude that only the vertical integration resource is "VRIO". This potential source of competitive advantage is valuable as it enables the company to have greater flexibility and adaptability which can lead to a resilient supply chain. This resource is also rare because it is uncommon for the industry players to have almost all the components

under the control of the headquarter. To establish a vertical integration for this complex and multiplayer supply chain would require an incredible amount of capital and time to reach this level, therefore we can consider this resource as inimitable as well. And lastly this resource is usable inside of the organization as the firm effectively utilizes this strategy to optimize its operations.

Q2 / b: The company's dynamic capabilities

Based on the Dynamic capabilities framework we can analyze the organization's resources which enable the companies to continuously innovate their skills and functional competencies to meet evolving market dynamics.

As sensing opportunities, the Task Force Team plays a crucial role in quickly identifying and evaluating changes in the external environment. The cross functional team is responsible for risk management, and they warn the company once they expect some external shocks. The team is encouraged to think differently due to the agile company culture, in order to identify opportunities, create contingency plans and response effectively to disruptions.

To seize those identified opportunities the company has to make strategic decisions such as vertically integrating the supply chain components and keep transparent, fast communication with the suppliers. These steps are about maximizing the organization's benefits from the opportunities.

Transforming refers to adapting the company's strategic direction in response to a changing external environment. By reallocating the limited semiconductors to optimize production processes the company was able to deliver in time many models. Through prioritization of top-selling vehicles the company achieved a competitive advantage and had the ability to adapt to shifting market dynamics.

Q3: Advantages and disadvantages of the company's vertical integration

Considering supply chain management as a cohesive and integrated system and eliminating intermediary markets, the company can benefit from numerous advantages, however we have to keep in mind some disadvantages as well.

Advantages:

- Operational efficiency: Vertical integration allows the company to streamline transportation logistics and manufacturing operations from raw materials to final

product delivery. By managing transportation internally and controlling production processes directly, the company can optimize efficiency, reduce costs, reduce lead times, reduce inventory, as well as improve the responsiveness and adaptability to changing market conditions and customer demand.

- Greater control and higher resilience: This strategy reduces the reliance on third-party providers which can mitigate the risks associated with external shocks. By expanding the company's ownership over several supply chain stages, like semiconductor and steel production, transportation and factory machines, the OEM is able to ensure smooth business continuity.
- Flexible and fast reaction: The company can make agile production and manufacturing adjustments in response to changing market conditions and other supply chain disruptions. This flexibility enables the company to response faster and be ahead of its competitors.
- Quality control: The greater ownership over key factors within the supply chain can ensure adherence to quality control, which can lead to enhanced product quality, more reliable brand image, extended customer base and higher customer satisfaction. The high quality of the products was also a significant reason why many premium brand customers switched to this brand.

Disadvantages:

- Over-reliance on internal suppliers: Although vertical integration reduces the dependence on external, third-party suppliers, it creates over-reliance on existing internal suppliers. If some of the components of the integrated supply chain underperform or even fail, it could disrupt the whole supply chain through the ripple effect. It is also challenging to negotiate a new contract with another supplier as it could take for months or years.
- Managing complexity: While by streamlining the operations and simplifying product line, the company is able to avoid many complexities during the manufacturing and transportation processes, however managing an integrated supply chain can lead to complexity. Coordinating multiple operations and functions across different stages of the production can pose challenges in terms of coordination, communication and alignment of the goals.
- Increased costs: This strategy requires significant investment in managing numerous stages of the supply chain, such as steel production facilities, transportation vehicles,

factory machines. These long-term investments can be beneficial in the future, however, to establish these contracts and to acquire every facility the company have to spend a significant amount of capital.

Q4: Strategic response to crisis - Retrenchment, Persevering, Innovating and Exit

Given the fact that the chip shortage affected the entire supply chain of the firm on a global level, we can consider different strategic responses for different components. From Wenzel et al.'s 2020 paper, "Strategic Responses to Crisis" we can take into consideration four strategies to react to the semiconductor crisis. It is important to mention that the Retrenchment, Persevering, Innovating and Exit responses are not necessarily exclusive of one another.

The company has to Persevere and keep the status quo of many aspects of the operation as the cycle times, lead times and the entire supply chain itself are significantly long with multiple production stages. Given this complexity, it is not possible to start producing another vehicle in a short period of time, especially during uncertain times. Modifying any part of the product line and exploring other products would be resource-intensive and time-consuming while optimizing the existing offers can be an optimal solution to react. The company also has to meet regulatory standards and ensure the same product line with the same quality to not risk reputation damage.

The area where they can utilize Retrenchment is to focus on low trim level cars. This common response can reduce the scope of the organization's business activities, to not offer different trims, only the lowest with the most basic features for example by eliminating popular features, like heated seats. Naturally to sacrifice the nice to have features and only offer the must to have ones would damage the reputation and would lead to customer dissatisfaction, but in this case, it is a necessary step to take. This is not only enabling the company to save semiconductors but also reduces the complexity of the manufacturing process. By prioritizing the high demand cars, the company can improve its focus on the most profitable product lines, which can also increase transparency and efficiency.

The company can Innovate its strategy by establishing a new team for crisis management. In this term the company can broaden its perspective and gain more valuable insights about market trends, consumer behavior and potential external threats, opportunities. Within the company this is another sector which can enable the firm to have a more precise forecast and adapt faster to new market dynamics. Usually investing in R&D, innovating the product line, and integrating new cutting-edge technologies is a beneficial strategy especially within the automotive

industry, where thanks to the rapid technological advancements (AI, IoT), the whole industry undergoes a transformative shift. However, such a complex manufacturing process is not recommended during uncertainty.

Since during the chip crisis, the company had to allocate a limited number of chips, some low performing models and nice to have features had to be sacrificed which means they had to stop produce them – Exit – for a temporary period of time. By freeing up some chip resources the company can benefit more from the other top-selling cars, which can lead to higher competitiveness and market share.

6. Limitations

When analyzing the case study, it is important to keep in mind some limitations. Due to the fact that only the headquarters' upper management perspective was integrated, the research may result in a biased view of the company's strategy. Different subsidiaries and markets (especially outside of Europe) may have their own specific complexities and challenges that are not represented in the data gathered from the European Headquarter. Also, it is challenging to generalize the findings from a broader perspective. The uniqueness of the chip shortage case may limit its applicability to another context. Conducting more detailed case studies, incorporating multiple perspectives, and analyzing a broader range of the subsidiaries and markets would enhance the representativeness and generalizability of the findings.

Another limitation of this research is that the company was restricted in providing any company specific information including sales data of different models resulting in a lack of depth and precision. Furthermore, there is a lack of a reference point, such an in-depth analysis of one of the competitors' strategies. This is why it may not capture all challenges and opportunities of the phenomenon overlooking some important factors from different companies and markets. A more holistic approach would provide a deeper understanding of the challenges involved.

7. Conclusion

To conclude with a summary of this academic paper, the case provides a managerial perspective of the way the analyzed OEM has reacted to the semiconductor chip shortage.

The crisis posed significant challenges for the automotive manufacturers globally, stemming from a combination of factors such as Covid-19 pandemic, increased reliance on chips, supply chain disruptions, unique characteristics of the automotive industry and geopolitical tension.

However, seizing the crisis as an opportunity the organization was able to react quickly to the changing market dynamics and become a clear winner by leveraging its adaptive strategies and utilizing the resources and capabilities that they have built up over the years.

One of the most important takeaways is the need for enhanced resilience, and flexibility. By implementing operational adjustment such as prioritizing the high-demand vehicles enabled the company to effectively manage the limited semiconductors and maintain operational continuity.

The vertical integration of the key supply chain components also played a crucial role in mitigating vulnerability to external disruptions, demonstrating the strategic advantage of greater control over critical resources.

Furthermore, establishing a Task Force Team helped the company to assess potential risk and respond effectively to disruptions. By emphasizing the need for crisis management, they can prepare for future external shocks by constantly analyzing the market trends and developments.

Overall, this case study underscores the importance of proactive strategic management practices in effectively navigating crisis within the automotive industry. By embracing change the company not only mitigated the disruptions caused by the chip shortage but also emerged stronger and more resilient, setting a precedent for effective crisis management and adaptive strategy in the automotive industry.

It illustrates that each bump on the road is not a barrier but rather an opportunity to accelerate innovation and drive the company towards success.

Appendix

Appendix 1: Table of the Product Team Interview Guide, Questions

The Product Department Team Interview Guide and Summary appendix provides essential insights gathered from recorded interviews which were conducted in English with members of the Product Department at the analyzed OEM. This appendix provides a clear overview of the interview process, highlighting key questions and offering a summary of the team's perspectives, professional knowledge and experiences in terms of the semiconductor crisis time. By examining challenges, strategies, and lessons learned - such as navigating the chip shortage - this resource offers valuable insights into the company's methods for product development, short term planning, supply chain management, and business resilience.

Hello and welcome to the interview!
Thank you for dedicating your time to meet with me today. This interview is expected to last approximately 60-90 minutes. As part of my Master Studies at Católica Lisbon University, I am currently conducting research for my thesis. Specifically, I am exploring how car manufacturers had to adapt their strategies in response to the chip crisis. Your insights and expertise will be invaluable in contributing to this study. Please note that this interview will be recorded for accurate documentation and analysis purposes, however the names and the sensitive, confidential information won't be shared.

Company overview and standard strategy:

1. Can you provide an overview of your role, and describe the daily processes of your team?
2. How does the team typically approach strategic planning and decision-making processes? Can you describe your current production strategy?
3. Can you describe the company's standard supply chain management practices and how they contribute to the company's overall strategy?
4. How does the company usually deal with production issues?

Chip shortage and the adaptive strategy:

1. How has the chip shortage affected the automotive industry?
2. How was your competitive environment impacted? Can you provide specific examples?
3. What were the primary challenges the company faced due to the chip shortage?
4. How did the company adapt its production and supply chain strategies in response to the chip shortage?
5. What kind of new processes and systems were applied?
6. Were there any specific vehicle models or market segments more affected by the chip shortage?

Learning from crisis

1. Describe the impact this strategy has had so far, what were the successes?
2. Do you think that with your new strategy your competitive advantage has been improved and why?
3. What lessons did the company learn from navigating the chip shortage?
4. How is the company preparing for potential future disruptions in the automotive industry, such as supply chain bottlenecks or technological shifts?

Appendix 2: Table of the Product Team Interview Questions and Answers

Company overview and standard strategy:	
Can you provide an overview of your role, and describe the daily processes of your team?	The employees I have interviewed are working at the European headquarter of an automotive company within the Product department which is responsible for both the present and future lineup of cars. Their role involves analyzing market insights, upcoming trends to strategically plan the development and production of the future car generation for the next four years (relatively short term), while also supporting the current vehicle production line. Some team members focus on analyzing real-time customer data and trends, while the others specialize in homologation and infotainment integration working on operational aspects. Collaboration with the global supply chain management team is an essential part of their daily routine. Overall, their job is to ensure that the company remains agile and responsive, fostering efficiency and innovation across the components.
How does the team typically approach strategic planning and decision-making processes? Can you describe your current production strategy?	It is important to mention that the company excels in adaptability thanks to its rapid top-down decision-making process. Although nowadays they can also initiate some bottom-up decision, at the end the final decisions come from the head. The top management is always focusing on how to adapt to the current market and how to react and change faster by constantly tracking the market changes. This mentality reflects their flexible culture. There is no standard production strategy, it varies region by region which enables the company to shift faster than its competitors. On the other hand, factories in Europe are very traditional as their production logic is still “make to stock”. In general, the production is inspired by Toyota’s efficiency principles which means that they try to streamline and simplify the product line and do not produce many options. Despite its status as a well-established multinational corporation, the company has a startup mindset where innovative, new ideas are supported. This means that there is no one "right" method to do anything, employees have their freedom to propose creative improvements.
Can you describe the company's standard supply chain management practices and how they contribute to the company's overall strategy?	The supply chain management system operates on a “make to stock” basis. This means that products are being pushed according to the forecast. Due to the direct lines of communication with suppliers - managed by the procurement division - communication is fast and transparent. It is also crucial that they heavily depend on internal suppliers which leads to a very complex network of processes. Their vertical integration is unique in the industry as they own and control many supply chain components including mining and producing their own steal, while they also own all the

	factories, machinery, ports, and vehicles used for transportation. This proves to be very beneficial and effective in today's ever-evolving business environment, and in times of crisis it provides a significant source of competitive advantage. As the company - unlike several of its competitors - is able to control every aspect of the supply chain, they can effectively manage resources, cost and quality. This level of integration offers a wider range of businesses under one umbrella and increasing the company's reach and influence. The company also benefits from the fact that their home country is an expert in low-level semiconductors that are vital in electronics manufacturing. Their strong supply chain management (nearly entirely owned by them), positions the company uniquely in this very competitive market landscape. These factors strongly represent agility, adaptability, as well as national identity.
How does the company usually deal with production issues?	With its exceptional flexibility, the company has not just managed to survive difficult times (e.g. Covid and semiconductor shortages) but was able to grow. Approaching each situation uniquely and customizing solutions for specific circumstances also enables the company to seize opportunities and navigate risks more effectively. With this agility and dynamic approach in mind, they are always prepared to embrace new opportunities and mitigate risks effectively. This is certainly key for continued success during crises or challenging times. *"Sometimes the solution can be quite simple. For instance, when faced with a shortage of keys, instead of providing two keys, we offer just one to the customer. This allows us to effectively double our supply."* This way customers could get their new car promptly and only had to wait for the additional key.
Chip shortage and the adaptive strategy:	
How has the chip shortage affected the automotive industry?	Before the start of the chip shortage, there was a significant drop in demand in 2020 due to Covid. Following this crisis, the market was unprepared for a rapid recovery. Restarting automotive production is not easy, it is expensive to shut down a factory and then start production again that naturally leads to delays. *"You cannot just turn on the lights in an automotive factory and continue manufacturing cars."* This, combined with the 'war' for limited semiconductor supplies, is one of the reasons why the chip shortage hit the automotive industry so hard. Thanks to its vertical integration and close relationships with suppliers the company was able to handle the situation better than many of its competitors that were suffering more.

How was your competitive environment impacted? Can you provide specific examples?	There was an intense ongoing competition for chips that required companies to adapt quickly in order to survive. "*You have to act like you are in war."* In this competitive landscape, the company was clearly one of the winners. Several competitors faced challenges: some struggled to satisfy demand, others were even unable to deliver automobiles. As a result, many customers had to wait for years to receive a new car. Although they are not considered as premium brand, the company drew a lot of customers away from premium brands. This was because the company's dealerships could provide cars relatively quickly, offering customers a shorter wait time compared to competitors.
What were the primary challenges the company faced due to the chip shortage?	*"How do you avoid shutting down factories, continue selling cars, and satisfy customers? How do you prevent closing networks with dealers and suppliers, ensuring that the existing system operates at a level that won't harm the business?"* As a result of the limited supply of chips there were longer wait times for customers and it was very difficult to meet customer demand. In order to avoid factory shutdowns and maintain operations, the company had to come up with creative solutions to continue selling cars. It was also crucial to be able to ensure customer satisfaction and keep maintaining good relationships with suppliers and dealers. This required prioritizing production of popular vehicle models, optimizing inventory management and transparent communication with customers regarding potential delays.
How did the company adapt its production and supply chain strategies in response to the chip shortage?	*"It made us think differently."* To minimize the effects of the shortage, it was inevitable for the company to prioritize production. They started to focus on their most profitable and popular car models and careful allocation of chips. It also meant that they needed to reduce production or delay less popular models. *"We were focusing on keep producing whatever gives us money and keep reducing the lower profit cars."*
What kind of new processes, systems were applied?	The management of the company created an emergency team, called Task Force Team (TFT), that consisted of members from various departments, such as manufacturing, procurement, and other relevant fields. This cross-functional group was working together in real time evaluating the situation and developing effective strategies. The diversity and expertise of TFT members helped comprehensive problem-solving and decision-making. As the information was gathered from various departments simultaneously, the company could quickly react and adjust its operations to lower the impact of the chip shortage. After the crisis, TFT disbanded, and the members returned to their regular roles and processes. *"Everybody is giving their perspective in the real-time reporting to management in a fast*

	way to be able to adjust the strategy and when the panic is gone, they go back to their teams."
Were there specific vehicle models or market segments more affected by the chip shortage?	Yes, certain vehicle models and market segments were more affected by the chip shortage than others. For instance, smaller cars were impacted more, because they tend to have less profit margin, therefore in their cases there were fewer resources available to adapt in case of supply chain problems. That was the reason why the company gave larger cars priority, as they typically have better profit margins. *"Our A, B segment cars has a lower profit margin than the C, D products which led us to focus on the later ones."* While this decision allowed the company to concentrate on maximizing profitability, smaller, less expensive car models sometimes suffered more serious shortages. In order to lower the use of chips and maintain profitability, the company decided to shift chips from base car versions to more equipped models. They have also simplified certain features in lower-trim vehicles to reduce the number of chips necessary. This strategy significantly helped the company to distribute chips strategically so that they could not just fulfill demand but could also maintain profitability in this challenging and competitive market environment.
Learning from crisis:	
Describe the impact this strategy has had so far, what were the successes?	Undoubtedly, this approach has brought extremely positive results for the company. Sales numbers and profit levels increased significantly due to the implementation of this strategy. But eventually the chip shortage crisis has been resolved and the market returned to normal and as a result the company now has to face with the levelling off of sales and market share. While the strategies adopted during the crisis were effective, the company now needs to maintain its competitive edge in a more "normal" market environment. *"Now we are back to normal, the competitors are catching up."*
Do you think that with your new strategy your competitive advantage has been improved and why?	Clearly, the company was able to significantly increase its competitive advantage with the new strategy implemented during the chip shortage crisis. With their flexible and agile approach, they could quickly adjust production to prioritize certain cars, trims and powertrains. This was essential to be able to successfully deal with the hectic chip supply and demand. As a result, the company could satisfy the needs of diverse customer segments and could take advantage of new business opportunities. Finally, these strategic initiatives also contributed to positive attention and interest from both current and potential customers and enhanced visibility and positive brand perception. Due to all these efforts, the company's competitive position has been further strengthened in the automotive industry.

What lessons did the company learn from navigating the chip shortage?	There were several valuable lessons learnt from the uncertain times of the chip shortage. The company discovered the importance of being flexible and being able to quickly adapt to changing circumstances. They also understood that thinking like a startup and adopting an innovative and agile mindset is also key to success. Lastly, they realized how dangerous it is to rely too much on external suppliers, and that independence is increasingly crucial on critical areas such as semiconductor production.
How is the company preparing for potential future disruptions in the automotive industry, such as supply chain bottlenecks or technological shifts?	In order to get ready for potential future disruptions in the automotive industry, proactive steps are being taken by the company. A new crisis management task force has been formed. Their objective is to find alternative solutions in case of disruptions and being able to rapidly report to management. With this approach the company will be able to make the necessary adjustments when changes occur in customer attitudes and/or market conditions. Furthermore, flexibility, adaptability and agility are now parts of the company's DNA. The organization is able to quickly seize new opportunities by the 'every day is a new day' philosophy. They can change the strategy without hesitation when needed since they avoid being overly committed to specific projects or strategies. *"Every project is different… the strategy is not having a fix strategy."* Furthermore, the company is diversifying its portfolio to reduce the risk of potential supply chain disruptions and/or technological advancements. They do not rely on one technology only (such as internal combustion engines, hybrids, or electric vehicles) and try to avoid dependence on a single region, so that they can be more resistant and stable when facing with uncertain market conditions.

References

- Aaker, Kumar, Leone and Day (2018): Marketing Research. 13th Edition.
- Amit & Schoemaker (1993): Strategic Assets and Organizational Rent https://www.researchgate.net/publication/243775502_Strategic_Assets_and_Organizational_Rent
- Applied Energy System (2023): Navigating Complexities: The Semiconductor Shortage's Effect on the Auto Industry. https://www.appliedenergysystems.com/semiconductor-shortages-effect-on-auto-industry/
- Barney, J. B. (1995, Nov 1): Looking inside for competitive advantage. Academy of Management Perspectives, 9(4). https://doi.org/10.5465/ame.1995.9512032192
- Barney, J.B. (2001): Is the Resource-Based 'View' a Useful Perspective for Strategic Management Research? Yes. The Academy of Management Review, 26(1), 41-56.
- Barney, Jay B. (2001): "Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view." Journal of management 27.6
- Barreto, Illídio (2010): "Dynamic Capabilities: A Review of Past Research and an Agenda for the Future." Journal of Management
- Boranova et al. (2022): Cars in Europe: Supply Chains and Spillovers during COVID-19 Times. https://www.elibrary.imf.org/view/journals/001/2022/006/article-A001-en.xml?rskey=iM9OLz&result=3
- Carnahan, S. (2017): Blocked but not tackled: Who founds new firms when rivals dissolve? Strategic Management Journal.
- Christopher, M., (2000): The Agile Supply Chain: Competing in Volatile Markets, Ind. Mark. Man., Vol 29, No. 1, pp 37-44.
- Cohen, P. (2021, November 2): How Car Shortages Are Putting the World's Economy at Risk. https://www.nytimes.com/2021/11/02/business/car-shortage-global-conomy.html
- Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., & Sheikh, A. (2011): The case study approach. BMC medical research methodology, 11(1), 1-9.
- Dai, L., Eden, L., & Bemish, P. W. (2017): Caught in the crossfire: Dimensions of vulnerability and foreign multinationals' exit. Strategic Management Journal.
- De Figueiredo, R. J. P., Feldman, E. R., & Rawley, E. (2019): The costs of refocusing: Evidence from hedge fund closures during the financial crisis. Strategic Management Journal.
- Dierickx & Cool (1989): Asset stock accumulation and sustainability of competitive advantage https://josephmahoney.web.illinois.edu/BA545_Fall%202022/Dierickx%20and%20Cool%20(1989).pdf
- Eisenhardt, K. M., & Martin, J. A. (2000): Dynamic capabilities: what are they? Strategic management journal, 21(10-11), 1105-1121.
- G. Stevens (1989): Integrating the Supply Chain.
- Gereffi et al. (2005): The governance of global value chains.
- Glaister, K. W., & Falshaw, J. Richard. (1999): Strategic planning: Still going strong? Long Range Planning, 32(1), 107–116
- Global Market Insights (2022): Top 6 Challenges Faced by the automotive industry. Top 6 Challenges Faced by the Automotive Industry: The Post-COVID-19 Era. gminsights.com

- Haozhe Chen, P. Daugherty (2009): Supply chain process integration: A theoretical framework.
- Hirani (2023): External factors affecting the automobile industry. https://ztcorporate.com/blog/external-factors-affecting-the-automobile-industry/
- Holweg et al. (2019): Supply Chain Collaboration: Making Sense of the Strategy Continuum.
- Houze Emmanuel (2018): The automotive industry and its future business model. https://www.researchgate.net/publication/332079596_The_automotive_industry_and_its_future_business_model_Master_1_thesis
- Hugo WMJ, Badenhorst-Weiss JA, Van Biljon EHB (2004): Supply chain management: logistics in perspective. 3rd edition, Pretoria: Van Schaik.
- International Labour Office (2009): Automotive Industry: Trends and reflections https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/publication/wcms_161519.pdf
- J.Arias (2022): Supply chain integration in the industry 4.0 era.
- Knoema (2022): Global Automotive Industry Overview. https://knoema.com/infographics/gdwntfe/global-automotive-industry-overview-dataandanalysis
- Köllner, C. (2022): Das müssen Sie zur Halbleiter-Krise wissen. Springer
- Kowal (2023): Challenges facing global automotive supply chain Challenges Facing Global Automotive Supply Chains. SupplyChainBrain
- Leenders, M.R & Fearon, H.E., (1997): Purchasing and supply chain management Chicago: Irwin, (11th ed).
- Lindner (2016): Global Automotive Industry Statistic. https://gitnux.org/global-automotive-industry-statistics/
- Lummus et al. (2001): The relationship of logistics to Supply Chain Management.
- Mansoor Shekarian, Mahour Mellat Parast (2020): An Integrative approach to supply chain disruption risk and resilience management.
- McKinsey & Company (2022): Semiconductor shortage: How the automotive industry can succeed. https://www.mckinsey.com/industries/semiconductors/our-insights/semiconductor-shortage-how-the-automotive-industry-can-succeed
- Monye et al., (2023): Now and future challenges of the automotive industry in the developing world.
- Pearce, J. A., & Robbins, K. (1993): Toward improved theory and research on business turnaround. Journal of Management.
- Pearce, J. A., & Robbins, K. (1994): Retrenchment remains the foundation of business turnaround. Strategic Management Journal.
  Professional. https://www.springerprofessional.de/halbleiter/halbleitertechnik/das-muessen-sie-zurhalbleiter-krise-wissen/19356172
- Ratu Farah Nadia (2018): The role of vertical integration in input procurement.
- Reuters (2022): London market green-lights Russia's palladium while blocking its gold London market green-lights Russia's palladium while blocking its gold. Reuters
- Reymen, I. M. M. J., Andries, P., Berends, H., Mauer, R., Stephan, U., & van Burg, E. (2015): Understanding dynamics of strategic decision making in venture creation: A process study of effectuation and causation. Strategic Entrepreneurship Journal.
- Saunders, M., Lewis, P., & Thornhill, A. (2016): Research Methods for Business Students (Seventh Ed). Essex: Pearson Education Limited.
- Schönfeld, M. Chipmangel (2022): Lieferzeiten von Neuwagen Lieferproblemen ziehen sich bis 2024. Auto Zeitung. https://www.autozeitung.de/chipmangel-200946.html

- Schuh C., W. Schnellbächer, A. Triplat, D. Weise (2022): The Semiconductor Crisis Should Change Your LongTerm Supply Chain Strategy. https://hbr.org/2022/05/ the-semiconductor-crisis-should-change-your-long-termsupply-chain-strategy
- Statista (2023): Automotive industry worldwide - statistics & facts. https://www.statista.com/topics/1487/automotive-industry/#topicOverview
- Statista (2023): Number of vehicles removed from production worldwide due to the semiconductor shortage in 2021, with a forecast for 2022 and 2023. https://www.statista.com/statistics/1288308/automotive-production-reduction-semiconductor-shortage/
- Statista (2023): Semiconductor unit shipments worldwide from 2000 to 2021. https://www.statista.com/statistics/802632/world-semiconductor-shipments/
- Stieglitz, N., Knudsen, T., & Becker, M. C. (2016): Adaptation and inertia in dynamic environments. Strategic Management Journal.
- Straughan (2023): The Semiconductor Shortage Explained: The Auto Industry's Big Challenge. https://www.automoblog.net/research/news/semiconductor-shortage-explained/
- Supply Chain Brain (2023): Challenges Facing Global Automotive Supply Chains Challenges Facing Global Automotive Supply Chains. SupplyChainBrain
- Tang D, Qian X (2008): Product lifecycle management for automotive development focusing on supplier integration, Computers in industry, 59: 288-295.
- Teece, D. J., (2007): Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. Strategic Management Journal, 28(13), pp. 1319-1350.
- Teece, D. J., Pisano, G., & Shuen, A. (1997): Dynamic capabilities and strategic management. Strategic management journal, 18(7), 509-533.
- Tobias Gerber (2012): Vertical Integration of decision relevant production information into IT-Systems of manufacturing companies.
- Wei Guan (2012): Vertical integration in supply chains: driving forces and consequences for a manufacturer's downstream integration.
- Wei Li, Jing Chen (2020): Manufacturer's vertical integration strategies in a three-tier supply chain.
- Wenzel, M. (2015): Path dependence and the stabilization of strategic premises: How the funeral industry buries itself. Business Research.
- Wenzel, M., Stanske, S. and Lieberman, M.B. (2021): 'Strategic responses to crisis', Strategic Management Journal. John Wiley and Sons Ltd, pp. O16–O27. https://doi.org/10.1002/smj.3161.
- Wong et al. (2018): Automotive global value chain Global Automobile Industry - Automotive Industry: A Research Guide - Research Guides at Library of Congress. (loc.gov)
- Xia, J. et al. (2016): Resolving a dilemma of signaling bankrupt-firm emergence: A dynamic integrative view. Strategic Management Journal.
- Xilling Wu et al. (2021): An Analysis on the Crisis of "Chips shortage" in Automobile Industry. https://iopscience.iop.org/article/10.1088/1742-6596/1971/1/012100/pdf
- Ziegler (2023): The Chip Crisis in the Automotive industry. https://www.isf-muenchen.de/pdf/The_Chip_Crisis_in_the_Automotive_Industry_HyValue_Study_2023_ENG.pdf