



**Impacts of the COVID-19 Pandemic on Supply Chains of the
German Automotive Industry**



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ABSTRACT

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Abstract

The COVID-19 pandemic has dramatically changed our daily lives in a very short time. International supply chains, such as those of the German automotive industry, have experienced major disruptions. Border closures or production stalls caused these supply chains to collapse due to increasing globalization on both the supply and demand side and the associated dependency on global flows of goods. This led to bottlenecks, fluctuations in demand as well as delays along the entire value chain. The aim of this paper was to illustrate the impacts of the Covid pandemic along the supply chains of the German automotive industry. Potentials were identified to be able to react more effectively against crises in the future. This work used literature review, and used various articles of management consultancies and statements of German car manufacturers. The obvious impact of the COVID-19 pandemic could be seen at border closures, government measures such as home office obligations, and lack of materials. Companies had to adapt their processes in a very short time and there was a drop in demand in the automotive sector. The theoretical findings identified four major factors that influenced the disruption of the supply chains. These included complexity, communication, risk management, and geopolitical factors. Due to the low vertical integration of the German automotive industry and the resulting high dependency on suppliers, the optimization of these factors is essential in order to be able to react better to crises in the future. A fundamental step could be the digitalization of supply chains and the transparency of communication between all parties. In addition, adjustment of inventories and procurement at a

national level should be taken into consideration, which is the key to ensuring supply chains for the obvious more disruptive future ahead.

Keywords: supply chain, German automotive market, COVID-19 Impact

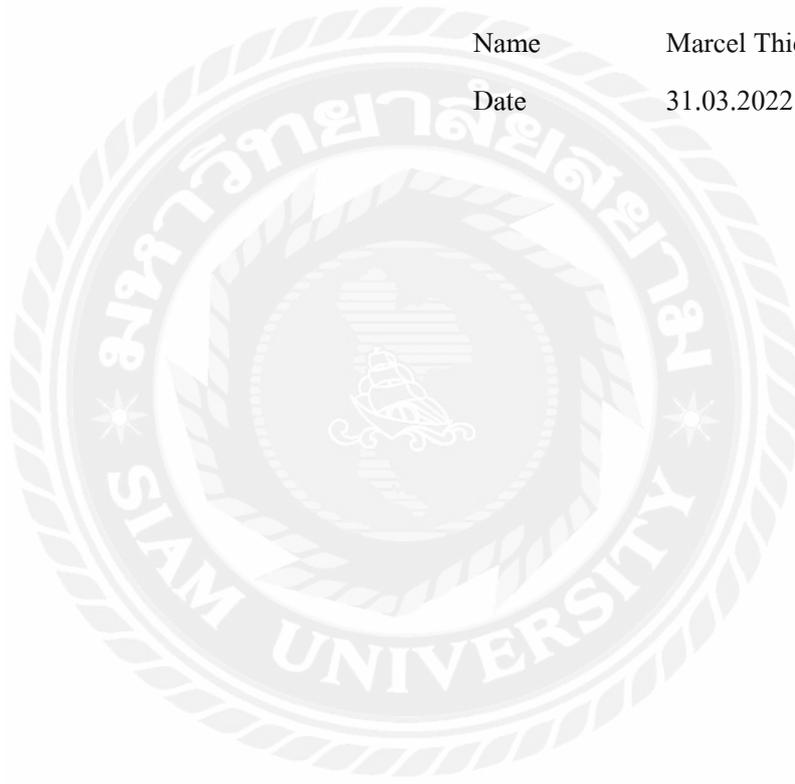


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1 Introduction

1.1 Research Background

The coronavirus, also known as COVID-19, has spread worldwide after its initial discovery in China in December 2019. Within months, the virus has become a global pandemic. As of September 2021, the virus has spread to more than 190 countries and infected more than 223 million people worldwide (Radtke, 2021). In Germany 4.2 million people have been infected with the virus (Statista, 2021).

The pandemic also massively affects all areas of daily life. These include, for example, exit restrictions, contact bans, compulsory masking, border controls or lockdowns. Globally, there is a profound impact on the economy. Here are just a few figures for Germany in 2020. Economic output slumped by 4.9%, with 4.2% the second highest government deficit since reunification or 74.5% fewer passengers (Destatis, 2021). The coronavirus has challenged the state, the economy and society in an unprecedented way (Knieps, 2020).

With annual sales of over 438 billion euros in 2019, the cornerstone of the German economy is the automotive industry. Furthermore, Germany is one of the largest car producers in the world. Well-known car manufacturers such as Audi, BMW, Daimler, Porsche, and Volkswagen contribute to successful sales worldwide. Almost two-thirds of annual sales came from abroad in this regard (Reichert, 2020). The automotive industry represents a very dynamic environment with constant changes. For example, virtually all automobile manufacturers are diversifying their product ranges in order to conquer additional market niches. Examples are cabriolets, or SUV's. Globalization also has a strong impact on the automotive industry. Cost pressure is leading to a reduction in vertical integration in many cases. This means that the production of components and parts is outsourced and purchased from supplier. Through this outsourcing, supply chains develop into a global affair. These supply chains were also affected by the COVID-19 pandemic (Kropik, 2009).

1.2 Research Problem

Globalization has led to the development of mostly international and highly complex supply chains in recent decades, particularly in the automotive industry, which has been highly affected by the COVID-19 pandemic (Deloitte, 2020). But what does this mean? The effects can be observed on the supply side as well as on the demand side (Janßen et al., 2020).

Border closures, production stops and transport bottlenecks have affected the supply side. (GTAI, 2021). These factors resulted in supply shortages of materials or products and political measures. At the borders of Europe, long queues for truck clearance could be observed. The keyword interrupted supply chains past to this obvious impact. There were also interruptions in production at automotive factories. Especially in March 2020, there was a flood of information on the spread, measures, regulations, and effects of the pandemic. For example, at Daimler, production was interrupted starting March 20 and employees were told to stay home to contain the pandemic (Sattler, 2020). However, the impact of Corona is much more profound.

The transport chain only looks at the transport of goods or the interruption of production on a company. But when we talk about supply chains, all supply relationships and all suppliers are involved. In the automotive industry, we are talking about a gigantic number of suppliers. The external procurement rate is often over 75%. If the supply of just one material fails, for example the supply of leather for car seats, it can lead to the production lines in Germany coming to a stop. The costs of this are enormous (Eßig, 2020). In addition, there was a demand-related disruption. (Janßen et al., 2020). As already described in the background research chapter, there was a decline in the economy. The first half of 2020 was characterized by an historic decline in the international automotive markets. The European market was hit hardest. 39% fewer vehicles were registered than in the same period of the previous year (VDA, 2020a).

The long-term consequences for supply chains are not yet foreseeable at this point in time. Nevertheless, companies are already increasingly considering whether processes should be adapted with the aim of being able to react effectively in crises. (Deloitte, 2020).

1.3 Objective of the study

This research aims to show how the COVID-19 pandemic effected the supply chains of the German automotive industry. In order to understand the impacts, the structure of supply chains will be illustrated and the short-term and long-term effects along the entire chain will be explained. Finally, potential changes in the supply chain management process will be elaborated to be able to react more effectively in future crises.

1.4 The Scope of the study

This paper covers various aspects of COVID-19-related impacts on automotive supply chains. The issues are identified through documentary research in theses, journals, articles, books

and more. Search engines such as 'Google Scholar' or 'Emerald Insight' and relevant websites are also used to bring together relevant information. The time period under analysis starts with the outbreak date of the pandemic, i.e., December 2019, until the completion of this paper. Potential future changes in supply chains may extend beyond this period.

1.5 Research Significance

In recent decades, the global supply chains of the automotive industry have been characterized by the outsourcing of production stages and the sourcing of pre-products from abroad as a profitable strategy. Currently, however, the question arises to what extent the associated risks caused by the pandemic can be justified (Kolev & Obst, 2020). This research study was anticipated to yield at least the following useful significance as following:

- To provide an overview of the impacts caused by the pandemic. It shows the effects and can help provide more transparency in the supply chain.
- To highlight the long-term actions. What can we learn from the pandemic to be better protected against crises in the future?

2. Literature Review

In this chapter, the theoretical foundations of the supply chain are explained. This is followed by a description of the German automotive industry. Finally, the COVID-19 pandemic is discussed in order to define its impact on the supply chain.

2.1 Supply Chain

Supply chain is a complex topic with many influencing factors. For this reason, after the development and definition of the supply chain, this section will also discuss supply chain management, identify motivations, and point the objectives.

2.1.1 Development and Definition

Due to advancing globalization and changes in sales markets, the value-adding processes (products are processed or refined in order to obtain a higher value) are no longer limited to the company's own boundaries. In fact, they extend from the raw material supplier to the end customer (Baumgarten, 2004). This also implies that there is a global and wide-ranging view and companies

have formed an entire corporate network. The term supply chain has become established for this network. Despite this, many different definitions of the term can be found in the literature (Werner, 2004).

The following definition by Göpfert (2004), Corsten and Gössinger (2001) seems to be relevant for this work. A supply chain is a cross-company value chain that includes the stages from the upstream supplier (tier 1: component supplier, tier 2: parts supplier, tier 3: raw material supplier) through logistics service providers, distribution centers and the original equipment manufacturer (OEM) to retailers and end customers. The chain consists of material, information, and financial flows.

The idea of a value chain was first mentioned by Porter in his book “competitive advantage: creating and sustaining superior performance” (Porter, 1985). Also according to the early logistics, the physical flow, i.e., of a material, was clearly divided into procurement, production and distribution operations. However, regarding a single company (Pfohl, 2004). Over the years, companies have discovered that a cross-company perspective and planning can achieve much better optimization results than an isolated view of a single company (Kuhn & Hellingrath, 2002). The following figure illustrates the network in a simplified way.

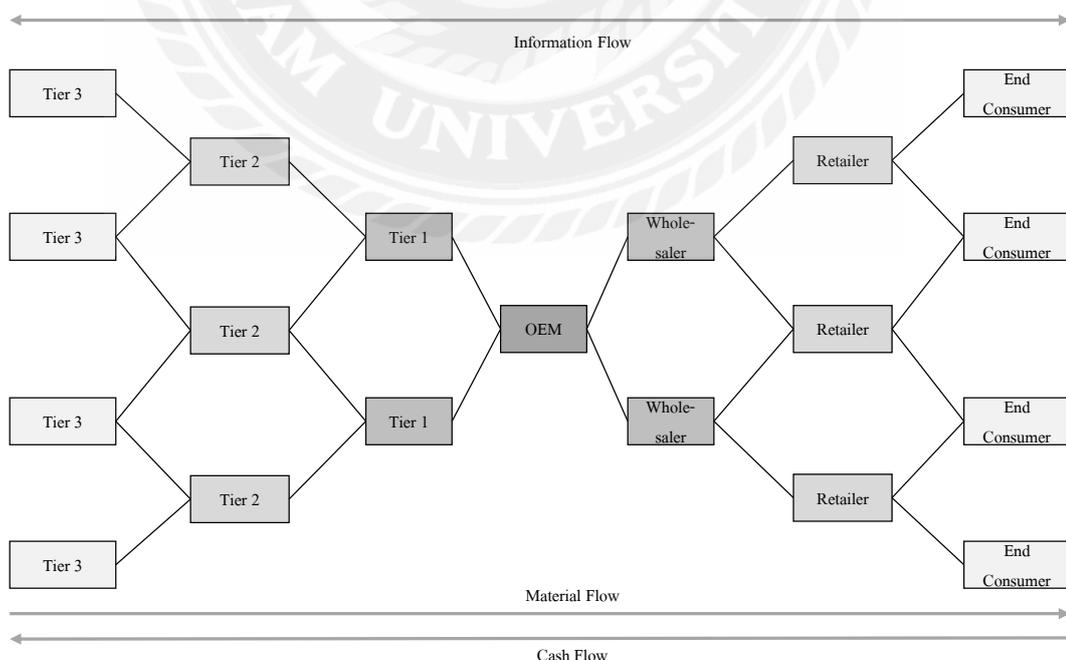


Figure 1: Example of a supply chain and the components (adapted from Hieronimus, 2006, p. 49.)

The figure illustrates different participants of the supply chain by squares, which are connected with edges. These connections show the relationships of the actors. The arrows symbolize the flow of materials, information, and cash flow. Direct relationships can also exist, for example, between raw material suppliers and OEMs or any other combination. There are no limits.

There is also some controversy in the literature about the term supply chain since it refers to a complex network. Sydow (2002) defines the term as a logistics network. An enterprise network with tasks to the operational and strategic logistics management. However, the previous definition of a supply chain goes far beyond the logistics chain as individual participants cannot make decisions in isolation, instead the entire chain is controlled by a collaborative management (Corsten & Gössinger, 2001).

2.1.2 Supply Chain Management

In theory and in practice, there is no standard definition of the term supply chain management. Based on the definition of a supply chain in the previous chapter, Kugeler (2002) defines the supply chain management as the planning, management, execution, and control of the entire value chain from raw material extraction to the end customer, taking into account material, information and financial flows. Werner and Thorn (2003) define supply chain management similarly, but in more detail. Here, the terms order acquisition, order processing and product delivery are used. The two authors also define the term supply chain planning. This includes all planning tasks that occur in the supply chain management and therefore represents a field of activities. The supply chain management also focuses on interfaces between companies. For this reason, it is also referred as interface management (Kloth, 1999). Internally, this refers to interfaces between different departments. Intercompany interfaces are between suppliers and customers (Melzer-Ridinger, 2005).

The customer demands nearly every product should be available at any time and any place. This is due to the increasing demands of society as well as technological progress (Böhnlein, 2005). Here is one motivation to join forces and align supply chain as efficiently as possible with customer demand (Baumgarten, 2004). Companies are also increasingly focusing on international procurement markets. Value creation is decreasing, while networking between companies is increasing. The complexity of supply chains is increasing as a result of the relocation of work steps to foreign (often Asian or Eastern European) locations. The functioning of the supply chain depends

on successful cooperation (Geimer, 2005).

Most goals in supply chain management can be achieved by connecting all actors and synchronizing development, manufacturing, delivery, and information. One of the most frequently mentioned goals is to increase delivery service and to react quickly to changing customer needs. In this context, an improved market position against competing supply chain is targeted (Böhnlein, 2005). To achieve the goals, a constant balance between effort or cost and the benefits of savings associated with the goals is required. For example, the goals of responding quickly to customer needs and market changes while achieving profitable growth are in conflict. The conflicting competitive factors of quality, cost, time, and flexibility must be realized (Keller & Krol, 2004).

2.2 German Automotive Market

According to the definition of the German Association of the Automotive Industry (VDA), the automotive industry consists of the production of motor vehicles of all types that are necessary for the transportation of people and goods. This includes the automobile manufacturers and the supplier industry, which produces car parts and equipment (VDA, 2007). Automotive manufacturers (OEMs) are enterprises that combine components, modules and other similar items produced in-house or by third parties into complete vehicles and offer them to the end consumer. The externally sourced components are purchased from suppliers. This includes all economic units that supply intermediate products or provide services for a company downstream in the value chain as part of the inter-company distribution of activities (Wallentowitz et al., 2009). The structure of the actors is shown in Figure 1.

The value chain in the automotive industry is highly diversified. Parts, components, and raw materials are largely purchased for vehicle production. The supplier industry benefits as a result. These include material and parts supplies from the chemical industry, mechanical engineering, or the electrical industry. Furthermore, car dealers, repair shops and gas stations are directly or indirectly dependent on the automotive industry. As mentioned in the research background chapter, the automotive industry has a major significance for the German economy. The German Federal Ministry for Economic Affairs and Energy (BMWi) defines the automotive industry as the largest sector of the manufacturing industry and the most important industrial sector in Germany in terms of sales. This is reflected in the fact that almost 833,000 employees earn their living in this sector. (BMWi, 2021). The largest employers in Germany and in the automotive field

are the Daimler AG with approximately 166,500 employees (Kaleta, 2021), Volkswagen Group with approximately 120,000 employees (Volkswagen AG, 2021) and the BMW Group with approximately 90,000 employees (Manager Magazin, 2020).

German automotive production is ranked among the world's largest manufacturer. In terms of vehicle sales, Volkswagen sells the most vehicles after Toyota (Japan) with 9.16 million vehicles in 2020. Daimler with 2.84 million, and BMW with 2.33 million vehicles are also among the 12 largest manufacturers worldwide (Kords, 2021a). The export sector is the most important for the German automotive industry. Most recently, around two-thirds of passenger cars produced in Germany were exported to other countries. The most important buyer countries include China, USA, England, and France (Kords, 2021b). For this reason, access to foreign markets is a key issue for the automotive industry (BMW, 2021).

2.3 COVID-19 Impacts on Global Supply Chains

The impact of the COVID-19 pandemic on global supply chains has been enormous. National and international restrictions such as strict border controls caused a negative impact on supply chains (Kumar & Managi, 2020). In recent years, companies have aligned their supply chains according to different strategies. For example, lean or flexible systems have been introduced to better coordinate or visualize them in order to identify weaknesses and save costs. However, the implementation of the strategies has not been sufficient to avoid the negative impact of the pandemic (Olorunfoba, 2020).

The rapid spread of the virus disrupted supply chains. Supply shocks, demand shocks, the bullwhip effect (fluctuations in demand in the supply chain), transportation requirements and costs are the major effects (Zhu et al., 2020). The main influence on these effects is the possibility for companies to buy supplies. Border closures have strongly influenced business activities or the transportation of goods. In China, government measures have shut down the production of entire industries. Since many supplies in the automotive industry also come from China, companies were no longer able to receive the required supplies, therefore their production also had to be stopped. In this context, upstream and downstream supply chain partners were also disrupted. Due to the lack of materials, production had to be stopped here as well (Barter, 2020). This resulted in shortages for end consumers and surpluses for suppliers or manufacturers. These effects are related to the bullwhip effect, which occurs when swings in inventories increase due to demand fluctuations. The

main reason is the lack of transparency in the supply chain. Changes in demand are partly due to panic buying and stockpiling. This shifted demand, which many companies were not prepared for. Large companies were able to manage this shift in demand, while smaller companies were forced to stop production (Parson, 2020). Border closures significantly increased transportation costs. Some of the raw materials are requested by air. Due to the pandemic, many flights could not take place and new ways of procurement were needed. This resulted in a worldwide increase in costs. In addition, new safety measures and regulations affected costs and delivery times (Zhu et al., 2020).

3. Past Research

Researchers have examined the coronavirus impact on global supply chains. According to Taleb (2012), global supply chains are designed for high efficiency and cost reduction, which is why they have become vulnerable to disruption. This thesis is supported by Pedersen & Nyländer (2021). The two authors were able to gather insights from different companies through interviews and illustrate the impact on companies, such as delays or financial impact. The impact was also confirmed by a global survey that interviewed more than 173 business managers and leaders from various industries about the negative impact of the COVID-19 pandemic on their supply chains (Mazareanu, 2021). Another focus of the research so far is on factors that influence the disruption of global supply chains by COVID-19. Factors were identified that influence disruption and therefore can be prevented under certain circumstances. These are complexity, communication, risk management and geopolitical factors (Pedersen & Nyländer, 2021).

Pató & Herczeg (2020) were able to show that the automotive industry was extremely challenged. They took a slightly different approach. In their work, which is based on a case study, solution paths were defined based on the challenges, which focused on trouble-free production. In their opinion, inventory choice and organizational strategy are key aspects in the crisis. Köllner (2020) mentioned the sales losses due to the pandemic in Germany. Furthermore Humphrey & Lechowski (2020) examined the structural changes that emerge from the pandemic-induced demand crisis in the automotive sector. In particular, the disparate impact on small firms or the influence of national governments on governance processes in the industry.

Regarding to the German automotive industry, no scientific work could be found at the

present time. The German Association of the Automotive Industry has regularly disclosed positions. For example, the industry association speaks of historic sales declines, particularly due to the lack of exports (VDA, 2020a; VDA, 2020b). There have also been various analyses by consulting firms. Deloitte, for example, has shown through a survey that the automotive industry could already see positive signals in 2020. The dependence on components and process steps is defined here as an elementary obstacle. Nevertheless, the export business could be seen as a rescuing link, in particular due to sales numbers in China (Proff, 2020). Until today, there have also been regular press releases from the German automotive industry. This revealed how the individual manufacturers are dealing with the COVID-19 pandemic. The focus was on production stoppages and financial aspects (Sattler, 2020; Volkswagen, 2020).

4. Finding

The following findings were obtained from the literature review of the coronavirus impact to the supply chains of German automotive market. Figure 2 illustrates a conceptual framework established based on the findings of the research.

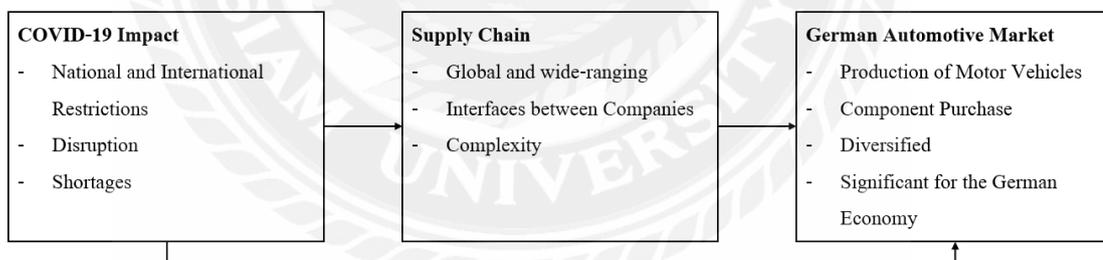


Figure 2: Conceptual Framework Model

(Kumar & Managi, 2020); (Oloruntoba, 2020); (Parsons, 2020); (Zhu et al., 2020); (Parson, 2020); (Werner, 2004); (Corsten & Gössinger 2001); (Melzer-Ridinger, 2005); (Pfohl, 2004); (Kugeler, 2002); (Geimer, 2005); (Keller & Krol, 2004); (VDA, 2007); (Wallentowitz et al., 2009); (BMW, 2021); (Kords, 2021a)

4.1 The Coronavirus Impact to Supply Chains

The COVID-19 pandemic had many impacts on supply chains. However, the following impacts have had the greatest impact. As a result of restrictions, delays occurred. The largest delay

was found in inventory. This category also includes postponements of projects, which has affected the entire value chain. The type of work has also changed in the form of home office. These changes can be positively attributed to the fact that employees are more flexible in their work. Negative effects, on the other hand, could be seen in the customer relationship or in the reduction of social interaction. A major impact can certainly be attributed to the financial impact. Sales decreased, prices for raw materials increased and, in some cases, production had to be reduced. Another impact was the travel restriction on the supply chains. International travel bans affected production and thus international supply chains. But also, third party verifiers had negative influences. Overall, it can also be observed that smaller firms experienced more delays and sales decline than large firms. Large firms, in turn, have downsized their employees rather than smaller firms (Pedersen & Nylænder, 2021).

4.2 Impact to the German Automotive Market

There was significant drop in automobile production due to corona measures, especially at the beginning of the pandemic, 1st half of 2020. In Germany, over 600,000 fewer motor vehicles were produced as planned by June 1, 2020 (Kords, 2020). According to the German Association of the Automotive Industry, sales fell by approximately a quarter in 2020. Although the Chinese sales market recovered comparatively quickly, the level was still below that of the previous year (VDA, 2021). This is also reflected in the sales figures for the German automotive industry. With sales of €378.17 billion in 2020, that's about €58 billion less than the previous year and the worst figures since 2014 (Kords, 2021c). All manufacturers were affected in addition to production stops of closed registration authorities as well as the decrease in demand of the consumers. Nevertheless, the development of the various car manufacturers was quite different. Daimler and BMW (sales down 7.8%) showed a much lower sales decline than Volkswagen, for instance, with 15.1% (Autozeitung, 2021). Due to the very complex structure of the supply chain, a large number of automotive suppliers have also been affected. They cover around 70 – 80% of the value chain. They have also been forced to shut down or stop production (Köllner, 2020).

4.3 Main Factors to Reduce Coronavirus-Related Supply Chain Disruptions.

Furthermore, due to the disruption of supply chains, factors can be defined that can lead to a resilient response to pandemics and disruptions in the future. Among the factors are complexity, communication, risk management and geopolitical factors. The complexity factor includes the size

of supply chains, type of production (among others Lean and Just in Time) as well as the type of production (national or international). The communication factor includes, especially, the transparency within the supply chain. The type of information processing (manual or automatic) and the relationship with suppliers have a great influence. Risk management is characterized by resilience. The risk can be reduced due to redundancy in the form of multiple suppliers or extra resources. Robustness also belongs to this category. The financial situation of a company as well as safety inventory has a great influence in this context. The final factor, geopolitical factors, is very difficult for companies to manage. This category includes restrictions (domestic, international, travel bans, infection control rules and climate conventions) and governmental support (tax packages, support schemes and dispensation) (Pedersen & Nyländer, 2021).

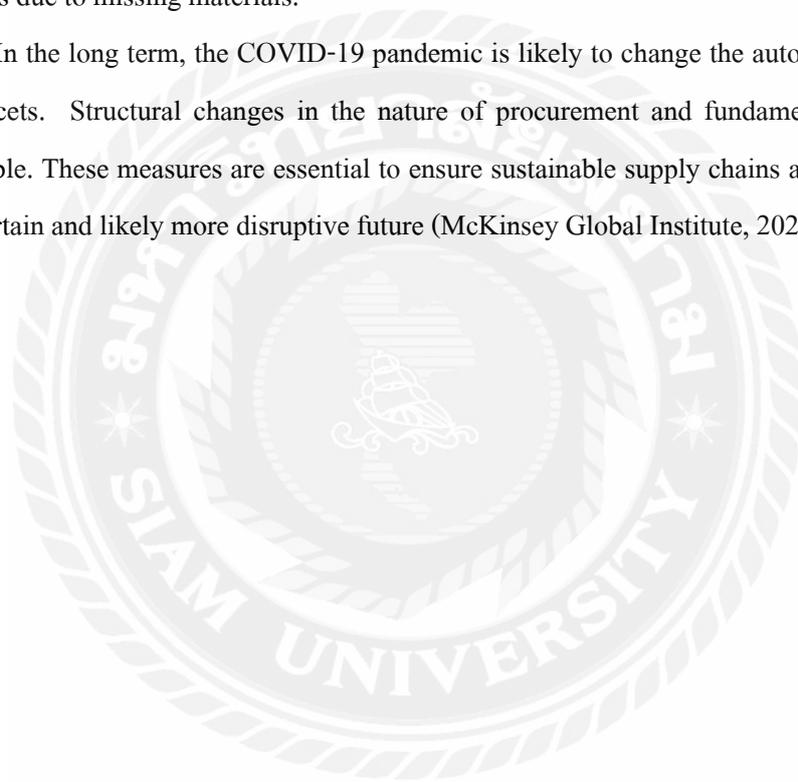
5. Conclusion and Recommendation

The aim of this paper was to show the short-term and long-term impacts of the COVID-19 pandemic on supply chains in the German automotive industry. Finally, potential changes should be presented in order to be able to handle crises better in the future.

It could be shown that the supply chains were massively affected by the short-term effects such as production stops or border closures. In addition, these effects and the decline in demand led to a huge drop in sales. In this context, the automotive industry was hit hard due to its low vertical range of manufacture and the resulting dependence on a large number of suppliers. The complex structure of the supply chains intensified this effect. This is why the focus on complexity, communication and risk management is essential in order to be able to resist crises in the long term. Digitized supply chains provide assistance in this regard and have many advantages. Among others, it can ensure the real-time tracking of goods as well as uninterrupted communication between all parties involved in the supply chain (Casey & Wong, 2007; Mansfield-Devine, 2017). Digitization also supports the objectives of supply chain management. Companies should also place a high priority on risk management. Plans should be created by all key suppliers and customer. Ivanov & Sokolov (2013) were able to show with their work that this allows a better response to disruption. In the best case, risk management should be digitized in the same way as the supply chains. By integrating a cross-enterprise supply chain monitoring system, companies can also become more flexible, organized, and responsive to disruptions. Another impact of the pandemic could also affect

previously established lean management strategies such as keeping inventories as low as possible. Especially for critical materials, higher safety stock levels could compensate missing materials at least over a longer period. (Pató & Herczeg, 2020). However, companies should keep in mind economic factors as the costs due to increased inventories and develop an appropriate strategy. The currently dominating global sourcing of parts could also be affected as a result of the pandemic. In this context, companies could also consider producing critical materials locally, thereby decoupling geopolitical measures from governments such as border closures and avoiding production stoppages due to missing materials.

In the long term, the COVID-19 pandemic is likely to change the automotive industry in many facets. Structural changes in the nature of procurement and fundamental strategies are foreseeable. These measures are essential to ensure sustainable supply chains and procurement in the uncertain and likely more disruptive future (McKinsey Global Institute, 2020).



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