# MANAGEMENT CHALLENGES FOR AUTOMOTIVE INDUSTRIES IN DIGITAL AGE BASED ON THE PERSISTENT COVID-19 PANDEMIC

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***Abstract:*** *Technological progress is advancing further and faster. This coupled with globalization has simplified our life many times over. Worldwide production and supply chains ensure a faster and more cost-effective process for many companies. Over the last few decades, these processes have been further refined to achieve the best possible results. This also includes the German automotive industry. Which has continued to expand and become the largest industry in Germany. However, a pandemic that occurred in 2019 was enough to shut down production. The mutated coronavirus has been keeping mankind in special situation for more than 2 years and will probably be with us for several years to come. The economic damage is enormous, so that in stable countries the state had to help keep them alive. As the leading industry with most employers in Germany, the automotive industry got weakened over the past two years in several sectors. This deals with the damage that has occurred, the long-term consequences that are still to come, and possible solutions to be able to fight upcoming pandemics more efficiently with the help of digitization. The focus here is on the German automotive industry.*

## 1. German Automotive Industry

Germany is known as country of poets and thinkers. As early as the 18th century in the Weimar classic era, exceptional talents like Goethe or Schiller conquered the continent with unique pieces (pohlw, n.a.). Later, the Central European state was able to score points with world-changing innovations and set new standards. For example, Carl von Dreiss developed the first bicycle, Johannes Gutenberg invented the letterpress, and the first car was also built by Carl Benz in Germany (Kodzo, 2020). In fact, there are a lot more innovations, but these three helped the world evolve into what we know today.

Cars have been developed as luxury goods and evolved in many different sectors. Nowadays the different dealerships offer a high range from low budget up to high end one-of-a-kind cars. That's only the private sector – the business sector is steady growing and offering tailor made solutions (Transformationswissen BW, n.a.). Whether taxis, buses or special conversions such as emergency vehicles or armored products are produced and sold on request. This is no longer about niche sponsors but an important part of the main business. It is precisely this variety of offers that is necessary in order to remain viable for every modern company. From the Rhine Neckar metropolitan region alone, which is a fraction of Germany, more than 40 innovations that are widespread worldwide have emerged (Kurpfälzer Meile der Innovation, n.a.). This pattern continues into the current era. In 2020, the first breakthrough in terms of a successful COVID-19 vaccination was achieved in Mainz (Food and Drug Admnistration USA, 2020). The patented vaccine pioneered and saved the lives of countless people. As of today, more than 5 billion doses have been administered, which is roughly a third of the world's population (Thelitz, et al., 2021). The first nations managed to vaccinate more than 70 percent of their population in

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about 8 months. This is often reflected positively in everyday life, as the cases of illness are often very harmless and further measures are therefore superfluous. A great advantage for the automotive industry, as they try to return to the usual work rhythm as long as possible.

If you look at the German companies with the highest market value today, you'll see among the top ten, alongside big players like SAP or BASF, automobile manufacturers like VW, Daimler or BMW (Frankfurter Allgemeine Zeitung, 2020). Thanks to many years of experience and multi-layered product portfolios, these were able to establish themselves globally. Globalization made it possible to set up international plants, shortening supply chains and working with more suppliers. In addition, the vehicles in the factories could be adapted to country-specific requirements (International Organization of Motor Vehicle Manufacturers, 2017). Customer demands are changing at ever shorter intervals. This correlates with increasing digitization and the associated innovations. The vehicle no longer sees its purpose merely in transporting the occupants safely from a to b. It is becoming much more of an unforgettable experience. It becomes much more of an unforgettable experience. Safety assistants continue to be improved to minimize the risk of accidents and make the driver more comfortable. Whereas in the past radio and air conditioning were among the most important optional extras, nowadays they have become a standard feature. Instead, the focus is on novel features. These include onboard Wi-Fi or cell phone connectivity such as Apple CarPlay or Android Auto (Hägler, 2017). As progress continues to accelerate, the lifetime of a vehicle has also decreased. Whereas up to the millennium vehicles were built for ten years and more, it is now common to market a facelift after just three years and to launch a completely revised model after a further three years. At first glance, six to seven years may not sound like a very short period of time, but you have to take into account what the manufacturer has to deal with. Legal requirements have to be fulfilled, the wishes of the stakeholders have to be met and, in addition, new production chains have to be created (Grünweg, 2013). The development of new vehicles is an ongoing process that is firmly anchored in the company. Daimler AG, for example, spent around 9.66 billion euros on research in 2020, almost doubling its research expenditure from 2010 (Kords, 2021).

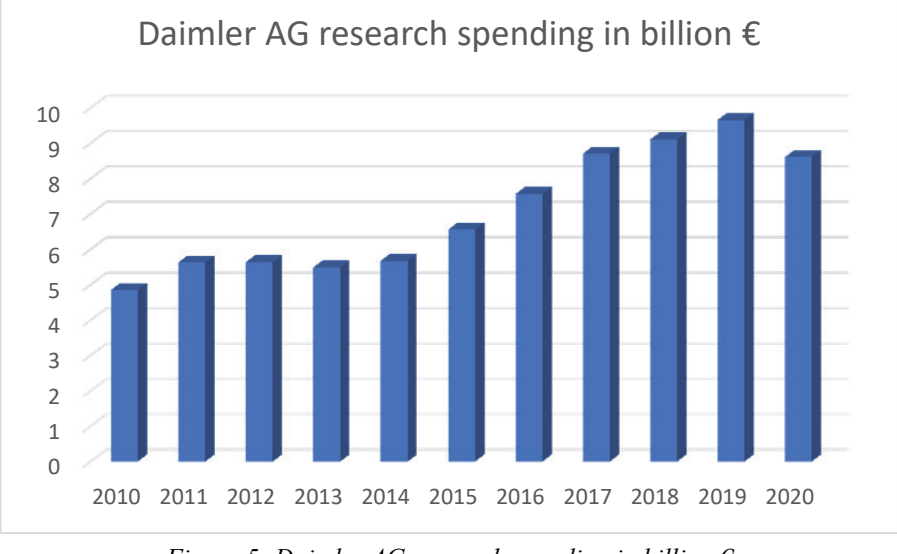


*Figure 5: Daimler AG research spending in billion €*

These expenditures are necessary in order to continue to maintain market share. In addition, trends are identified at an early stage and can therefore also be implemented promptly. Despite the VW diesel scandal, in which customers were fraudulently deceived by manipulating the exhaust values and thus suggesting clean vehicles, Daimler is investing almost three billion euros in a new diesel series (Eisert, 2016). Even though diesel-powered vehicles have fallen out of favor in many respects in recent years, they are still considered reliable and fast long-distance vehicles. Regardless of the environment, the customer often pays attention to the consumption as well as the fuel prices, which are usually cheaper with diesel vehicles. Especially in the commercial sector, diesel-powered vehicles are almost exclusively offered and used. The majority of these are buses and trucks.

Aftersales is also getting bigger and bigger. Various suppliers around the world are engaged in finding customized solutions. Regardless of whether sports cars are made even sportier, vans are converted into motorhomes or limousines are equipped with the highest standard of luxury (NTT DATA, 2019). In 2017, the approximate turnover of aftersales was about 800 billion US dollars and is estimated to increase to 1.2 trillion US dollars by 2030 (McKinsey/CLEPA, 2017).

Regardless of this, new trends are constantly developing. In urban areas, it is often unprofitable to own a car. Increased traffic density and a modern infrastructure often make them superfluous for everyday use. This is being exploited by old hands like Deutsche Bahn, which is expanding its own rail network with high-performance lines. An example of this is the line from Mannheim to Stuttgart. By car, this takes at least 1 hour with little traffic. This is about 140 kilometers via the autobahn. By train, on the other hand, it is only 99 kilometers, which can be covered within 37 minutes (Deutsche Bahn, 2019). In terms of time and effort, this is often easier, but the money factor also plays a role here. Often train tickets, especially if they are purchased shortly before departure, are considerably more expensive than the actual trip with your own car. If this is then occupied by more than two people, rail transport is no longer profitable.

However, consumer thinking has also changed as a result of the upcoming generations. For young people in particular, the car is less a status symbol and more a means of transportation. This was also recognized by private companies and the automotive industry, which were able to intervene accordingly. New mobility solutions were created to meet customer demands. These include, above all, car sharing providers. The principle is simple: the user pays for the vehicle only as long as he uses it. Here, it is an all-inclusive price. Insurance, taxes and fuel are included, and some municipalities even cooperate with the providers so that parking is free, as in Brussels. Settled is exactly after return. There are several options, but the following two are the most used. Either it is settled after kilometers or after the used time. In addition, more and more mobility providers have entered the market in recent years, making the vehicle redundant within the city (Mackprang, 2021). After regulatory consultations and the elimination of concerns, electric e-scooters were approved. In hot summers, when cities and their public transport systems are often overloaded, these are a welcome change. In addition, one has no time commitment and is free in his route. The automotive industry had to face all these challenges even before the COVID-19 crisis. Often, these were also foreseeable trends that had been factored in over the long term. BMW, for example, established its own car sharing service, Drive Now, which also offers special vehicles for certain occasions. Porsche is tapping into the lost rental car market by also renting out their luxury vehicles directly. In 2021, Germany has 228 carsharing providers offering 26,220 vehicles across the country. Despite the ongoing Corona pandemic, the fleet has grown by 3.2 percent compared to the previous year. Since

the registration process is mostly very simple, as well as digital and free of charge, the growth is much greater. Here, 2,874,400 participants were registered at the beginning of the year, which means an increase of 25.5% compared to the previous year (Bundesverband Carsharing e.V., 2021).

It is noticeable how the global change is progressing, and which hurdles are connected with it. The points slightly touched on above are market requirements that were foreseeable for the automotive industry and were calculated accordingly. This is one of the reasons why the German automotive industry is at the top of the global league table. If you look at the German companies with the highest market value today, you'll see among the top ten, alongside big players like SAP or BASF, automobile manufacturers like VW, Daimler or BMW (Frankfurter Allgemeine Zeitung, 2020). Thanks to many years of experience and multi-layered product portfolios, these were able to establish themselves globally. Globalization made it possible to set up international plants, shortening supply chains and working with more suppliers. In addition, the vehicles in the factories could be adapted to country-specific requirements (International Organization of Motor Vehicle Manufacturers, 2017). German automotive manufacturers are also in leading positions globally. In 2020, the Volkswagen Group was in first place, although it is fair to say that the Group owns more than 10 vehicle brands. These include a wide range of brands, such as Audi, Volkswagen and Skoda, but also Porsche, Lamborghini and Bugatti. German automotive manufacturers are also in leading positions globally. In 2020, the Volkswagen Group was in first place, although it is fair to say that the Group owns more than 10 vehicle brands. These include a wide range of brands, such as Audi, Volkswagen and Skoda, but also Porsche, Lamborghini and Bugatti. The manufacturers Mercedes and BMW ranked 12 and 13, which is associated with the smaller portfolio and higher prices. It is obvious that the sales of cheaper vehicles are higher (Handelsblatt, 2020).

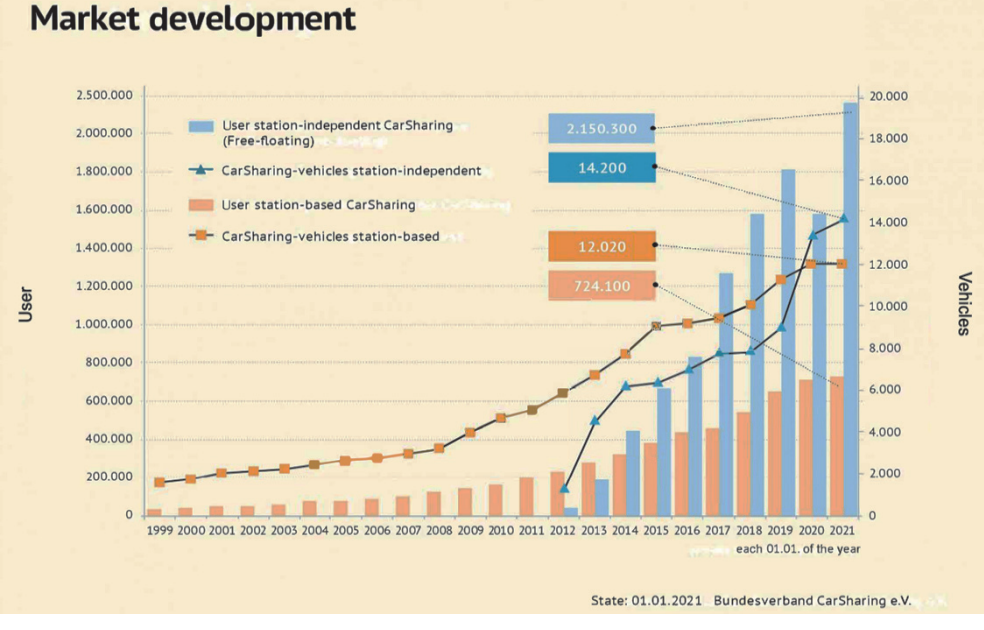


*Figure 6: Market development*

Nevertheless, globalization and outsourcing can lead to considerable disadvantages, even if only in the rarest of cases. The ongoing COVID-19 crisis is precisely one of these cases. The German automotive industry sent a large part of its workforce on short-time work. This is one of the first indicators of a protracted crisis.

The last comparable case dates back to 2008 and can be traced back to the economic crisis at that time. At that time, Daimler AG experienced a sharp drop in sales, which correlated with the fall in purchasing power, and therefore had to put its employees on short time working. 20,000 employees were affected by this measure, which brought them wage cuts. But even the remaining 80% of wage payments could not be covered by the company, so that the state had to pay about 60-67% itself (Deutsche Welle, 2008). At that time, Daimler AG experienced a sharp drop in sales, which correlated with the fall in purchasing power, and therefore had to put its employees on short-time working. 20,000 employees were affected by this measure, which brought them wage cuts. But even the remaining 80% of wage payments could not be covered by the company, so that the state had to pay about 60-67% itself. Later, people spoke of the automotive crisis that had developed from the financial crisis. This developed from the concatenation of many unfortunate factors. In addition to the reduced purchasing power, there were also rising prices for raw materials, such as oil, and adjusted CO2 taxes. Thus the purchase decision was strongly affected, since it was not clear which type of drive would be of use in the future. In addition to the established drives such as diesel and gasoline, the era of hybrid vehicles began, even if they were still far from the current standard at that time. Here it was also shown how intimate the interaction between suppliers and producers is. At that time, automotive suppliers were 75% involved in the production of vehicles and thus suffered the most from the consequences of the crisis (Rüther, 2009). The COVID-19 crisis, which occurred suddenly but on a large scale, caused many supply bottlenecks and production stoppages. This problem is most noticeable in sectors that use components that are also used by other industries. For example, semiconductors (Segal, 2021). These are chips that are very versatile due to their special properties and are therefore used for almost every technical device. A car could us the most advanced technique but wouldn't be able to start without semiconductors, the cockpit wouldn't work, and necessary components wouldn't react (Busse, et al., 2021). These can hardly be obtained, especially in 2021, and thus lead to major delays in the completion of orders. While the process from ordering to delivery took an average of three to six months, the whole thing is currently delayed for six or up to twelve months. Even if the industry secures itself and does not promise any fixed delivery dates but has only given forecasts based on the orders since then, this casts a negative image on the manufacturers. While the process from ordering to delivery took an average of three to six months, the whole thing is currently delayed for six or up to twelve months. Even if the industry secures itself and does not promise any fixed delivery dates but has only given forecasts based on the orders since then, this casts a negative image on the manufacturers. Semiconductor chips were very cheap to procure, which is why most manufacturers did not attach importance to their own production. However, since there are only a certain number of producers, they were also dependent on them. The shortage that occurred at the beginning of the year will continue in the third quarter of 2021 and does not appear to be easing. But not only German car manufacturers are affected, also big players like Toyota expect a production shortfall of 40% for the month of September. (Ploss, 2021). The Asian vehicle manufacturer, which ranks second in the number of vehicles produced

worldwide, expects to produce about 500,000 vehicles in the month of September. The target figure is around 900,000 vehicles (Kölling & Roman, 2021).

The peak of this bottleneck was due to the influence of other factors that were not foreseeable at the time. The cargo ship „Ever Given“ was on its way to Rotterdam and had to pass through the Suez Canal to reach its destination. The canal, which is one of the most important sea trade routes and extends over about 200 km, is used daily by at least 50 cargo ships, each carrying about 14,000 containers. On the way to pass the canal, the Ever Given got caught in a storm in May, which turned the ship around and made it run ashore. Due to its very narrow design with a width of between 280 and 345 meters, the canal was then no longer navigable.

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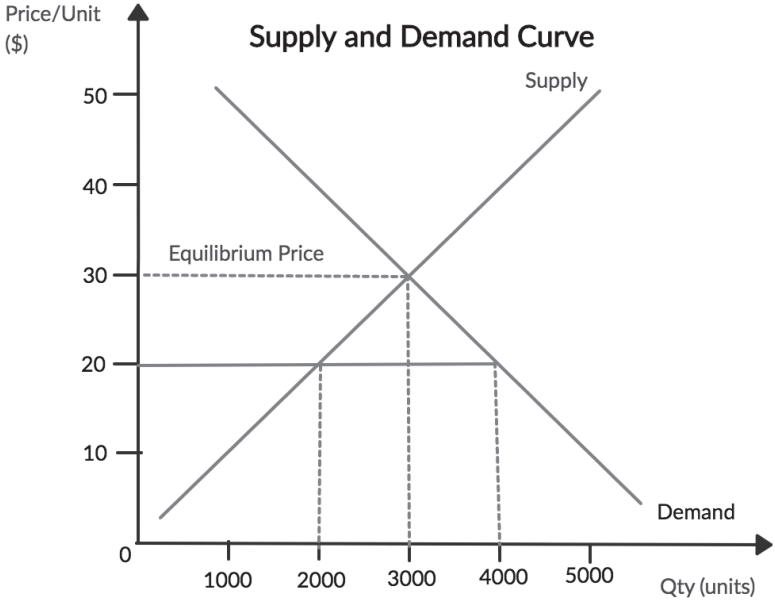


*Figure 7: Supply & Demand Curve*

Due to the international occurrence of the virus, many productions came to a standstill, despite increasing demand. Thus, a shortage was created. Raw materials and means of production were lacking in all areas. When production, especially of vehicles, resumed, there was a lack of resources. As a result, some suppliers passed on the rising cost of raw materials directly to customers. Nevertheless, there were huge sales shortfalls, which also resulted in continued short time working (Link & Stefan, 2020). The Mercedes G Class serves as a good example for this. The SUV flagship of the Swabian automobile company has since been one of the most popular models and has resulted in long delivery times. In the meantime, however, they have gone so far as to compare the order with the existing vehicle fleet and to find the closest vehicle. While many parts of society were negatively affected by the pandemic, the upper class benefited more than average from it (Reeves & Rothwell, 2020). This is also noticeable among the various car manufacturers. Not every company got away with as much luck as Mercedes Benz, for example. However, some of the problems that ultimately led to inevitable drops in sales were not due to the owners but to the state's legislation to combat the pandemic. For a while, it was not possible to sell all types of vehicles, as the retail trade had to close, and sales were only carried out directly. Additionally, companies had to split their teams for minimizing the risk of infections and slowed down the production process (IFO Institut, 2021).

While companies are forced to work with changes, they learned to get more and more dynamic. Customer demands are taken seriously and must be implemented as quickly and in the best possible way. The stakeholders are a part of the company and need the right amount of attention. But even the most dynamic companies weren't prepared for such a fast change in Markets. The continuing fallout seems to be driving many automotive companies

to take new directions. In Germany, the trend is to take a step back from outsourcing and gain more control through in-house production. Supply chains per se cannot and will not be abandoned; instead, systems that create more transparency and reliability are to be expanded. This will also pave the way for identifying potential problems at an early stage. To counter all the pressure, the German company Bosch is investing in its own semiconductor production. The company, which was founded in 1886, has more than 390,000 employees and achieved a turnover of 71.5 billion euros in 2020 (Robert Bosch GmbH, 2021). These revenues were achieved by operating in various industries as a supplier. Especially in the German automotive industry, they have created a solid and reliable foothold. More than one billion euros have been invested in order to be able to ramp up reliable and independent production by the end of 2021 (Hofer & Buchenau, 2021).

So back to the digitalization, which is rushing on new stages. How wasn't it possible to use these improvements and prevent upcoming crisis? Back in 2019, the German automotive pioneers Mercedes and BMW started a joint venture to get the maximum effort out of autonomous driving cars. The first products were planned to be released in 2024. This had been one of the most important projects in the automotive industry. It was paused as a side effect of the corona crisis. The companies sales decreased and the project costs were higher than calculated (Manager Magazin, 2020). Technology standards are growing rapidly. Several years ago, it was luxury to have a WIFI hotspot inside the car. Nowadays most manufacturers provide it as an option for all their cars. The external conditions adapt more and more quickly. The Internet of Things is becoming more and more diverse and offers more links and application possibilities. In particular, the 5G internal standard introduced in late 2019 opened new doors with its extremely high transmission rates.

If one sees this development, one wonders how these advances could not help to overcome the crisis. Even if the corporations have a lot of influence through their market value, we are still in a constitutional state that is controlled by the government. In any case, this tries to act for the benefit of the people. However, Corona made it clear that government representatives lack practical reference to reality. Unfortunately, resources were misused so that they delivered little to no success. Important applications such as the digital vaccination card or the corona warning app came onto the market late or uselessly. A major setback for the industrialized nation of Germany. If the state does not manage to deal with digitization personally and, if necessary, to cooperate with local companies, it makes the situation more difficult. As already mentioned in the previous text passages, there were more losers than winners due to the crisis. Even if big players managed to stay afloat, the trend is towards luxury electric vehicles (Dudenhöffer, 2021).

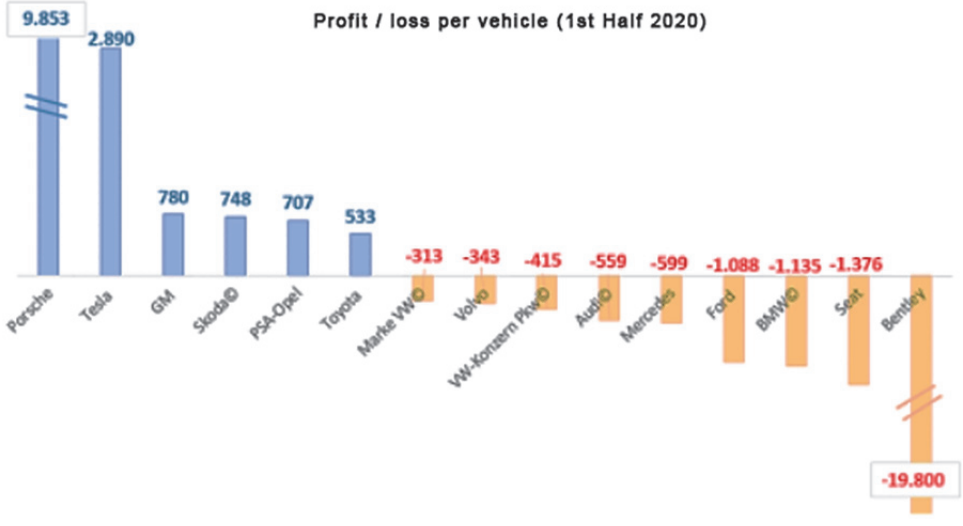


*Figure 8: profit / loss per vehicle (1st half 2020)*

Many manufacturers tend to switch entirely to the production of electric vehicles in the next decade. In many respects, this method may be better for the environment for the benefit of motor vehicles, but it also assumes a certain infrastructure that is currently not available (Feldforth, 2021). That is why the state is subsidizing this project with 300 million euros for the public sector, to create a comprehensive, open infrastructure by 2030. Independently of this, non-public charging stations are also subsidized to create incentives for private households as well as companies (Bundesministerium für Verkehr und digitale Infrastrukur, 2021). American pioneer and PayPal co-founder Elon Musk sensed this trend early on and reacted accordingly. In 2004, he invested in Tesla Motors, which had been founded a year earlier and is now known as Tesla Inc. Over the last decade, it developed into a pioneer of electric mobility and managed to establish itself as one of the only newcomers (Schink, 2018).

### 1.1. Cognition progress

The most important finding so far is no matter how advanced globalization or technology is, it will not help us if we do not act fast enough to find an end of the pandemic and rely on it. Nowadays companies are required to be able to demonstrate a certain agility. It is even more important to consider the needs of the stakeholders and to involve them (Hentze & Thies, 2014). At the state level, these factors simply do not seem to exist. The government focused exclusively on the one-off measures to counter the pandemic, thereby neglecting a large part of its population. For example, children and adolescents (Feuerbach, 2021). Their limitations in life have been shown to lead to increased psychological illnesses and general disorders while growing up. Alternatives were not offered and were never planned.

The industries were allowed to continue working but suffered from massive restrictions itself. These were within the company, such as production and sales, which were driven by short-time work, but also on the part of the customers. Most of these had suffered

themselves as a result of the measures, which is why purchasing power fell temporarily in many places. This cycle developed until the persistent cycle of the aforementioned supply bottlenecks occurred (Cakir, 2021)). Even after several months, when everyone realized that the measures introduced were of little help, the government insisted on continuing as before.

In the second quarter of 2021, the direction of approach was changed slightly, and the Covid test offensive was launched. The system offers several advantages. On the one hand, people get some freedom back, on the other hand, the number of unreported cases drops drastically, and cases of sickness can be tracked more easily. Finally, the automotive industry also benefits from this. Sales and production started again. However, it became noticeable here that globalization means that foreign suppliers are required. Like the German automotive industry itself, these suffer from the consequences of the corona virus. This resulted in bottlenecks in the semiconductor industry, which went so far that the delivery of certain models was stopped regionally, for example in the USA (Harloff, 2021). In Germany, the vehicles are only delivered with the necessary semiconductors and retrofitted later.

All in all, the failure cannot be traced back to a single one, but rather results from a chain of unfortunate events. None of the actors acted promptly or consistently enough that the suffering itself was made worse. Everyone should be aware by now that a pandemic cannot be ended in a few weeks. With the use of the right technology, it can be a lot less dangerous. These technical aids do not mean new acquisitions, but rather the tools that accompany us in everyday life, such as smartphones, mobile phones, and other devices. Even if the occurrence of a pandemic is statistically unlikely, one should always reckon with the risk of it occurring and take appropriate precautionary measures. Among the technology mentioned in this case are developed networks as well as powerful terminals such as smartphones. Today, these exceed the performance of a computer from 20 years ago many times over. More than 3 billion people own a smartphone and in 2020 about 1.2 billion new devices were sold (Tenzer, 2021).

The underestimation of the pandemic is now becoming apparent in the increasingly intense late effects. It is estimated that inflation in Germany will rise to about 4.1%. A value that has not been reached for about 20 years. This is having an impact on producers and end-users: prices are rising higher than purchasing power and supply is dwindling. The losers and winners are becoming increasingly clear. Mercedes Benz was only able to sell about 435,000 units in the months July to September 2021. At first glance, this may sound like a lot, but it corresponds to a minus of 30.5% compared to the previous year No improvement is expected in the coming quarter. This is due to the ongoing chip crisis. The fact that the figures did not fall further was due to the available stock, which was used in the best possible way. However, this is coming to an end and the materials are not sufficient to deliver supplies promptly. This means that sales have not yet reached their final low but are likely to fall further towards the end of the year According to initial forecasts, the automotive industry will lose about 210 billion dollars in sales in 2021 alone. To counteract this, manufacturers are increasingly focusing on the production of models with higher margins. Opel has gone one step further and completely close a plant in Germany by the end of the year. (Hubik, 2021). In addition to the already known problems, new negative events are always on the horizon. After days of congestion on the part of the freight carrier Evergiven, there are now global supply bottlenecks due to stoppages at ports. Whether Los Angeles or Rotterdam, the order situation can no longer be met. Ships are jammed for days

to be able to load and unload. For many companies, this means that some goods cannot be delivered in time for the Christmas season (Schlautmann, 2021). The trend is therefore not limited to the automotive industry but extends across all sectors. Whether food, petrol or iPhones, which are usually delivered in the fourth quarter of the year. Supply bottlenecks and rising prices can be expected everywhere. The price of diesel reached an all-time high of more than €1.50 per litre in October 2021. By comparison, in 2017 it was still around €1.05 - €1.10. But back to production figures. The tech company apple is planning an annual production of 90 million iPhones, but according to initial projections will miss the target by 10 million units this year (Knitterscheid, 2021).

## 2. Gap in Research

Regardless of the industry, this scenario was a novelty for most companies. The last pandemic of comparable magnitude was the Spanish flu and took place around 100 years ago in 1917 (History.com, 2020). At the beginning of the 20th century, the world was undergoing industrial change and was still far from globalization. After two years in the global COVID-19 crisis, it became apparent that some research gaps are still open. In order to cope with this as quickly as possible, various paths were taken and the requirements were adapted in relation to the German population. This began with restrictions on basic rights such as meeting with friends and relatives, retail lockdowns, and mandatory masks and restrictions on entering stores. This led to acute market reactions such as short-time work, material shortages and rising raw material costs. Later, contact tracking apps were introduced, which detect other devices when in use and enable contact tracking in case of a positive case. Assuming person A meets person B today and is tested positive the following day, now person B has visited 3 other people the following day and had close contact with 2 others through work. Now one would have to laboriously consider with whom and when the contact took place, but the app stores the data temporarily and can thus precisely track which contacts have taken place. This would require downloading and using the application. It is estimated that 60.7 million people in Germany own an Internet-enabled smartphone (Tenzer, 2021). With 83 million inhabitants, this corresponds to a rate of 73%. If you subtract small children and people in supervised institutions, this covers a large part of the population at risk. However, this is a best-case calculation. One assumes that all citizens are pulling in the same direction. However, many showed aversion to the innovative App because they feel their movements are being watched. Accordingly, the actual user figures are sobering. The responsible Robert Koch Institute reported just 25.7 million downloads in February 2021, which corresponds to only 31% of the population (Robert Koch Institut, 2021). Later, the digital vaccination certificate was also introduced. Even here, unfortunately, mine was later than expected. The first vaccinations were given in Germany around Christmas 2020, while the app was not made available until the middle of 2021 (Bundesregierung, 2021). This is more convenient for the user in terms of its usefulness than the classic vaccination certificate and is therefore also widely accepted. It shows when which vaccination dose was processed and creates a QR code that can be scanned and cross-checked. In addition, this is so far fully valid in the European region and will be extended to other countries in the future (Robert Koch Institut, 2021). This was the first reliable link to digitization. Unfortunately, this was done too late and had no influence on the course of the COVID-19 pandemic.

Therefore, the following research questions explore the extent to which digitization could have better helped manage the Corona pandemic.

## 3. Research Questions and Discussion

- How can digitalization help the companies getting prepared for upcoming crisis? Can the integration of digital solutions help to slow down the crisis and keep the branches running with less of loss?
- Is it possible to help the companies in need by using the newest standards and get faster solutions to end a crisis by working hand in hand (gov. & companies)?

Digitalization has certainly made life and certain processes much easier. Many technical masterpieces have become so well established in our everyday lives that they have become normal for the user. While the first computers were as big as garages, smartphones, which are also many times more powerful, fit in your pocket. The benefits of this are seen not only in the private sector, but much more commercial sector. Production processes are more precise due to digitalization, programs calculate stock levels and can act autonomously as soon as there is a shortage of stock, for example. For specific tasks such as operations, there are specially developed robots that can work with superhuman precision and calm. Progress continues apace, with no end to innovation in sight. Now the question arises why all these advances that we have implemented in everyday life have not been used to counteract the pandemic. Millions of dollars worth of apps have been developed, but unfortunately, they have not been adopted. To understand why this happened, we should take a step back. The only digital measures developed were the Corona warn apps. As previously explained, these track the user's history and can thus create a contact profile. The app was launched months after the Corona pandemic occurred. Since this scenario was a novelty. A completely new app had to be developed, which understandably takes time to make it marketable. Nevertheless, the government should try to reduce the development time to a minimum, especially when big players like Deutsche Telekom or SAP take over the complex process. For comparison, the development of the app took about as long as the development of the first vaccine from BioNTech (pure development time and not the time until approval by the relevant authorities). One should try to act as early as possible to be able to intervene if necessary. The car manufacturer Audi, a subsidiary of Volkswagen, has been advertising for years with the slogan „Vorsprung durch Technik“ („advantage through technology“). This should also have been the motto for managing the pandemic. The potential of the available technology was not nearly exploited. Once this was used, it happened much too late. Especially in crisis situations, processes must be completed at the highest speed in order to achieve a certain degree of effectiveness. The year 2021 shows the severe consequences for the German industry and especially for the car manufacturers, which, according to initial forecasts, will not be able to regulate their difficulties before the third quarter of 2022.

To answer the research questions, one should look at the technical possibilities from a different perspective. The use was always as an afterthought, but situations could be better managed with early indicators. These leading indicators like chip crisis or bottlenecks, which will be discussed in more detail later, should always be considered, even independently of the pandemic. The question is whether globalization has made us too dependent on suppliers. It is no secret that the automotive industry in particular is becoming increasingly dependent on its suppliers. Suppliers often adapt their production to the orders. This system offers many advantages because the focus is only on the core business. On the other hand, enormous storage costs are saved, and the material is often delivered just in time. As usual, contracts with suppliers are concluded in such a way that penalties are incurred in the event of a default. This creates artificial pressure on the suppliers. However, scenarios such as the ongoing Corona pandemic can also show how quickly this strategy

becomes useless. If German car manufacturers had pursued a strategy similar to Tesla's, they could even have grown. The US company takes the most necessary elements from suppliers and sets itself the goal of taking a large part of its production into its own hands. Even though it is often said that the quality is not comparable with German vehicles, the company was still able to sell vehicles as usual and increase production capacities.

In retrospect, we can see that we did not act until it was too late. The measures subsequently introduced were often hasty and not very effective. The automotive industry had to bow to the measures and had no say in the matter, despite the large market shares.

Starting with the first negotiations for the procurement of vaccines, the European Union failed miserably. While countries such as Great Britain sent negotiation experts in the field of pharmaceuticals, only direct politicians from the chosen fields were chosen on the part of the EU. However, these lacked expertise in negotiations and in the respective field, which is why the result was rather negative. This pattern also extended across the automotive industry. People with little to no experience in the industry made decisions that led to fatal bottlenecks. Even if Germany is a constitutional state, it should not only act narrow-mindedly and include this expertise in the form of a consultation or second opinion. A crisis cannot be ended overnight, nor can it be ended by individuals, companies or states. This process is very time-consuming and can only be managed collectively. Manufacturers such as Mercedes, Audi or BMW can hire the best managers in the world, but they will not bring you any added value as long as they do not receive any room for maneuver from the state. Only then can the full potential be exploited, and meaningful measures be developed. However, this also means implementing ongoing and future technologies in these processes. As already mentioned, these can work as early indicators when used correctly and thus allow the next steps to be planed. This may be a major international project, but it is the only reliable way to deal with subsequent crises of the same magnitude.

For the automotive industry, there are two scenarios that could lead to short-time work. The first is liquidity bottlenecks, such as the economic crisis in 2009. Due to a drop in purchasing power, orders also fell sharply, which meant low production. The other is when economic factors mean that supply chains can no longer be serviced. This scenario means the workforce is available, but not the working materials. Triggering such a disaster often happens quickly. Ending it again can take months or, again, years. For automobile manufacturers, this could even mean bankruptcy in the worst case. The ongoing technological progress must be used more efficiently. In industrialized countries, more and more people own a smartphone. What's more, many can no longer imagine their daily lives without a smartphone. The usage time for many is several hours a day and the functions are improved from year to year. In addition, the infrastructure is constantly being improved. The Internet standards are becoming higher and the lines stronger.

In addition to the daily problems, the German automotive industry now has to deal with tasks that had been handed over to suppliers. While until the crisis the focus was more on future trends such as low-emission vehicles, one should now consider slowing down the outsourcing. Further technological advances should be integrated into the process. This includes intelligent systems or state-of-the-art production machines. Care must be taken not to harm the suppliers, as they make up a large part of the industry and are associated with many jobs. The solution to be worked out must be hand in hand so that, at best, no job losses occur. Intelligent stockpiling is becoming more important than ever, as the situation shows that even if stockpiling is very costly, it is in a way indispensable.

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