



Driving Forces: Examining the German Automotive Industry's Growth within  
the Context of Megatrends

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## ABSTRACT

**Title:** Driving Forces: Examining the German Automotive Industry's Growth within the Context of Megatrends

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The globally standing German automotive industry, known for engineering excellence, faces a shift due to megatrends, reshaping the competitive landscape. This research paper assesses the German automotive industry's status quo and future outlook against sustainability, open innovation, and digital transformation. It involves a two-stage approach, starting with a literature review and continuing with exploratory interviews. The findings identify digital transformation and open innovation as key enablers for other megatrends. Sustainability is rather seen as a source of ideation. Often undervalued due to its indirect impact; it proves vital for societal benefits despite potential technological or financial constraints. Open innovation is distinguished as advantageous, but operational challenges may arise. Digital transformation is seen as strategically paramount and should be implemented across the entire organization for optimal efficiency. Here, it is vital to pay attention to change management practices. The German automotive industry is threatened by competition from China, the U.S., and Japan, which all present their unique advantages and threads. Especially China is a threat, driven by lower environmental regulations, fewer data protection laws, and a strategic decision-making approach that follows a just-do-it mentality. The study proposes for the German automotive industry to embrace a riskier decision-making approach. Additionally, to not rely on their engineering reputations and recognize opportunities that may arise through megatrends.

**Keywords:** Digital Transformation, Digitization, Sustainability, Open Innovation, German Automotive Industry, Performance, Strategic Decision-Making, and Business Model

## SUMÁRIO

**Título:** Forças motrizes: Examinar o crescimento da indústria automóvel alemã no contexto das megatendências

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A indústria automóvel alemã, conhecida pela sua excelência em termos de engenharia, enfrenta uma mudança devido às megatendências, que estão a remodelar o panorama competitivo. O presente documento de investigação avalia o status quo e as perspectivas futuras da indústria automóvel alemã em relação à sustentabilidade, à inovação aberta e à transformação digital. Os resultados identificam a transformação digital e a inovação aberta como factores essenciais para outras megatendências. A sustentabilidade é antes vista como uma fonte de ideias. Muitas vezes subvalorizada devido ao seu impacto indireto, revela-se vital para os benefícios sociais, apesar de potenciais restrições tecnológicas ou financeiras. A inovação aberta é considerada vantajosa, mas podem surgir desafios operacionais. A transformação digital é vista como estrategicamente primordial e deve ser implementada em toda a organização para uma eficiência óptima. A indústria automóvel alemã está ameaçada pela concorrência da China, dos EUA e do Japão, que apresentam vantagens e desafios únicos. A China, em especial, é uma ameaça, impulsionada por uma regulamentação ambiental menos exigente, menos leis de proteção de dados e uma abordagem de tomada de decisões estratégicas que segue uma mentalidade de "apenas fazer". O estudo propõe que a indústria automóvel alemã adopte uma abordagem de tomada de decisões mais arriscada, reconhecendo as oportunidades que podem surgir através das megatendências.

**Palavras-Chave:** Transformação digital, digitalização, sustentabilidade, inovação aberta, indústria automóvel alemã, desempenho, tomada de decisões estratégicas, modelo empresarial

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## ABBREVIATIONS

AAI	Automotive artificial intelligence
AI	Artificial intelligence
AR	Augmented reality
BMW	Bayrische Motorenwerke AG
BRIC Countries	Brazil, Russia, India, China & South Africa
BYD	Build your dreams
CO <sub>2</sub>	Carbon dioxide
CSR	Corporate Social Responsibility
ESG	Environmental, social, and governance
GDP	Gross Domestic Product
GM	General Motors
IAA	Internationale Automobil Ausstellung
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
KPIs	Key performance indicator
ML	Machine learning
MNE	Multinational Enterprise
OEM	Original Equipment Manufacturers
R&D	Research and development
SDGs	Sustainable Development Goals
SMAC	Social, Mobile, Analytics, and Cloud computing
SOI	Sustainable oriented innovation
SSI	Semi-structured interview
SWOT	Strength, weaknesses, opportunities, and threads
TUM	Technische Universität München
VDA	Verband der Automobilindustrie
VR	Virtual reality
VW	Volkswagen AG

## 1. INTRODUCTION

In business history, revolutions have emerged, that profoundly shape the present society. Starting by, the first industrial revolution in the 1760s was catalysed by the invention of the steam engine, which ensured a shift from traditional agrarian practices to manufacturing. Subsequent innovations have continually reshaped markets' societal frameworks. Presently, with the influence of 3D printing, digitization, the Internet of Things (IoT), AI-driven technologies, etc., we find ourselves immersed in the fourth industrial revolution, serving as a transformative stimulus across all sectors of industry and society at large (Philbeck & Davis, 2023).

The journey of the fourth industrial revolution is presenting opportunities for new operations, productions, and market dynamics. Companies and consumers are gradually shifting their processes, demands, and mindsets (McKinsey & Company, 2022). Despite a plethora of studies investigating the influence of digitization on the strategic landscape of firms, it still poses particular challenges for traditional and conservative firms. Additionally, climate change and technological disruptions emerge as megatrends to reshape global markets (PwC, 2022). In Germany, the automotive industry stands as one of the most successful sectors, with a turnover of 438.8 billion euros in 2019 and employing 833,000 people. The industry's evolution holds significant importance for both the nation and its populace (Dr. Schott, 2022).

The wave of transformation has given rise to new societal megatrends, restructuring the competitive landscape. Firms that adeptly navigate these shifts as opportunities stand as potential winners, this holds especially for multinational enterprises (MNE) (Cavusgil, 2022). Before diving into specifics, it is vital to define these megatrends, illustrate their significance, and explore their theoretical origins.

The first megatrend, that has shaped industries and society, comes along with the rising awareness of climate change and its with coming threads to humanity. While sustainability was seen as a cost of doing business in the past (Kennedy, Whiteman & Van den Ende, 2017), firms nowadays need to improve environmental and social performance while simultaneously building their competitive advantage (Kennedy, Whiteman & van den Ende, 2017). Consumers today are more aware of corporate social responsibility and how firms treat their stakeholders

long-term (Lindgreen & Swaen, 2010). It shapes a firm's image and can potentially result in a unique selling point. For example, Nestlé struggled to hold up a sustainable brand image and was accused several times of greenwashing. Perry Wheeler from Greenpeace stated: "Nestlé misses the mark with a statement on tackling its single-use plastic problem" (Perry Wheeler & Greenpeace, 2018) after Nestlé had announced to have packaging recyclable or reusable by 2025. This was only one of several public discussions that Nestlé had about behaving environmentally conscious. Ever since, they are often seen as unethical and having a troublesome time shifting away from this image.

Another megatrend, that comes along with the industrial revolution 4.0 is digitization. Digitalization has inspired several studies to illuminate its impact on a firm's strategy and decision-making. It involves leveraging digital technologies to reshape a business model, opening new avenues for monetization and enhancing processes. It encompasses the transition towards a digital-centric business approach (Gartner, 2023). As the literature review will reveal, various terms and business model classifications fall within the term digitalization. Companies see the need to adapt to this, to stay competitive. For example, Lego, a well-known toy producer, took the chance and drastically shaped it towards a digital operating model in 2016 to stay competitive. They shacked up everything from internal to external processes to transform digital (Gaiterova, 2021). This early adoption of a digital operating model turned out to be a success factor for LEGO, staying competitive ever since. Their new data management, platforms and digital business models improved their product output by an estimated 50% (Andersen & Ross, 2016). Hence, digitalization can disrupt the way firms work, and their business models and will hold a significant role in the future of industries and society as a whole (Brouthers, Geisser, & Rothlauf, 2016). In addition, digitization enables firms to operate more efficiently throughout the entire value chain and eases the internationalization process (Wentrup, 2016).

The rise of digitization has emerged in a more connected world and faster exchange of knowledge. Continuing with another megatrend, open innovation. Here, the innovation process is not solely undertaken internally, by a few members of the firms, but is open for discussion, idea pitching, and knowledge sharing. Open innovation is undertaken by a lot of firms and includes social and economic changes. For instance, working patterns, labour divisions due to globalization, the rise of new technologies to collaborate across distance, etc. (Dahlander and Gann, 2010). Innovation management is a following megatrend and transforms ways of

working to constantly innovate and adapt to stay competitive (Huizingh, 2011). Examples of open innovation include cooperation with for example universities, building accelerators of brands, partnerships, joint ventures, etc.

### **1.1. Problem statement and goal of this paper**

There has been a noticeable increase in research focused on the above-mentioned megatrends in the current body of literature. However, the current literature on the interdependencies of the megatrends is scattered and a literature review in English on the interdependencies of sustainability, digitalization, and open innovation in the German automotive industry was missing. Due to professional experience in consulting and academically acquired knowledge, there is a personal interest in filling this research gap. A literature review is necessary to unify existing findings, identify inconsistencies, and provide a future outlook on the development of megatrends.

Shifting our minds toward the German automotive industry, here the above-mentioned megatrends will be investigated. The German car market is a very traditional and successful one, in 2020, 106.57 billion tons of cars were exported out of Germany, with Volkswagen Group being the leading manufacturer based on global sales and the car industry makes up 16% of Germany's GDP (Statista, 2023). Since, the adoption of the megatrends and the fourth industrial revolution are essential to survive (McKinsey & Company, 2022), this paper aims to investigate the degree of change and influence on the German automotive industry. With new technology emerging, it will be difficult for Germany to stay the engineering leader in the automotive industry. Competition from China, Japan, and the U.S. is immense (Figure 1), and new trends like shared mobility, e-cars, flexibility, EU data regulations, environmental protection, and convenience will result in a break-or-make-moment for German car players. As displayed in the graph below, China is overtaking Germany in the segment of premium car production, with brands like BYD. Directly followed by Germany's main competition from the U.S. and Japan. Therefore, this paper will focus mainly on competition coming from these three countries.

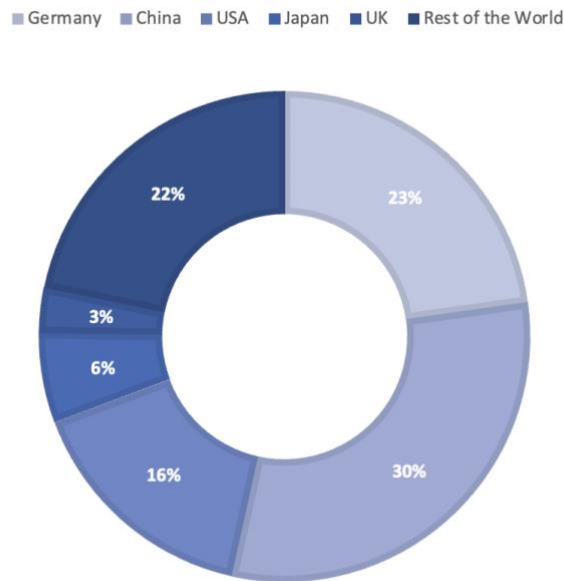


Figure 1: Premium car production by country 2023 (Statista, 2023)

## 1.2. Research Questions

In this thesis, the question of Darwinism is investigated in the German automotive industry to contribute to academic literature and provide venues for future research through a systematic literature review and primary data collection through exploratory interviews, on the influence of digital transformation, sustainability, and open innovation to the German automotive industry:

*Will the German automotive industry be able to compete, survive, and reproduce under the megatrends of sustainability, digital transformation, and open innovation?*

The systematic literature review will allow to investigate and analyse the aspects and influence of the megatrends on the German automotive industry that have only been partly addressed in recent scholarly work. To assess the problem statement further, the thesis is divided into four research questions that aim to solve the problem statement:

Research Question 1: How does sustainability influence the German automotive industry?

Research Question 2: How does digital transformation influence the German automotive industry?

Research Question 3: How does open innovation influence the German automotive industry?

Research Question 4: How do sustainability, digital transformation, and open innovation interplay amongst each other and the German automotive industry?

### **1.3. Research Objective**

As previously noted, the automotive sector plays a crucial role in Germany's GDP, serving as a significant income source. Yet, the megatrends of digital transformation, sustainability, and open innovation are set to disrupt the traditional business models in the automotive industry. The execution of these megatrends requires careful consideration, as evidenced by the fact that 69% of transformational projects fail (Carr, 2023), and approximately 40% of innovation projects encounter a high failure rate (Wang, 2023). For example, from a traditional car manufacturer to a mobility service platform. Through the offering of digital services, they could compete with players from other countries and markets, and live up to new customer demands (Cruz & Sarmiento, 2019). The innovation and maintenance of such services will need the appropriate knowledge, the right timing, and the adjustment of the organizational structure. If these are not adjusted, the automotive industry in Germany might fear not satisfying the dynamic customer needs and the coming flexible, agile, and innovative ways of operating to compete globally. Traditional companies have to ask themselves, how long they can hold to their traditional business models before adjusting or failing within their markets?

Several studies have examined the interdependencies of sustainability, digital transformation, and open innovation. However, due to professional experience as a student consultant at Capgemini Invent, insights into digital business models and the automotive industry have been gained by the author. Scholarly work is missing about how the interplay of these megatrends affects the German car industry. Furthermore, most companies do not address the interdependencies of sustainability and digitalization in general (Benetello, 2021). The study aims to investigate the future of the German automotive industry under the influence of megatrends and shape a coherent picture of what one of the most influential industries in Germany might face. It offers a comprehensive synthesis of existing knowledge, brings to light potential conclusions, and assists in pinpointing research areas that require further exploration. Lastly, it will provide recommendations and limitations for future research and offer managerial relevance.

#### **1.4. Thesis Outline**

To provide a sophisticated and qualified answer to my problem statement, my study will be structured as follows:

The subsequent section describes the criteria that led to the selection of journals and the identification of articles that built the literature review. It as well explains the concepts of sustainability, digital transformation, and open innovation and provides knowledge for this paper's problem statement. After providing accurate knowledge, the used methodology will be described with expert interviews and their coding process. In the fourth section, the literature and expert interviews are analysed, and recurrent themes are identified. Thereafter, the themes are compared and provide an assumption on the outlook of the German automotive industry. Lastly, this paper concludes by summarizing its contributions, answering the problem statement, addressing its limitations, and offering recommendations for future research.

## 2. LITERATURE REVIEW

### 2.1. Journal selection and article identification

Beginning the literature review, with the sample of journals determined to be included in the analysis. To ensure accessibility and comparability of the research, it will use English as the dominant research language. However, the chosen playing field is the German automotive industry and strong firms within, therefore literature sources can emerge in German for specific company and industry insights. Additionally, the focus will be on top-tier journals to gain editorial and expert findings.

In starting the research process, multiple electronic databases are accessed, for instance, ResearchGate, Science Direct, and Jstor. The focus lies on academic articles from journals of the given research field, for example, General Management, Marketing, Economics, International Business, etc. Within these journals, the keywords were filtered that represent the focus of the research questions. These, resulted in relevant articles to answer the research question, as well the conjunction of keywords offered new insights into articles. The search was extended by further investigating the big players in the German car industry, such as Audi, Mercedes, Bayerische Motorenwerke AG (BMW), and Porsche. A foundation of 35 articles was gathered, from highly reputable journals. The list of 35 articles was examined to Xiao and Watson's (2019) two-stage procedure to screen and select which ones to include in the review. Evaluating each article's abstract to determine their relevance to my research question and their overall worthiness for inclusion. Articles were only excluded if their content was repetitive to other articles or with a later publication than the 2001s (excluding definitions) in relevance to the megatrends, these are ever-evolving and research should focus on the present status quo to give meaningful insights. Hence, the majority of selected articles revolve around the time frame of 2013 until the present, providing accuracy and credibility of the literature review.

These 35 articles will examine how the three megatrends shape the German car industry and lay out the first theory for the analysis. Through conducting a systematic literature review, this paper aims to offer a comprehensive overview of the scattered literature, highlight existing research, identify where further investigation is needed, and provide advice for future research.

Table 1: Number of articles by journal and time period

<b>Journals</b>	<b>2001 – 2012</b>	<b>2013 – 2019</b>	<b>2020 – 2023</b>	<b>Total</b>
<i>Journal of international Affairs</i>		1		<b>1</b>
<i>The Academy of international Business</i>			1	<b>1</b>
<i>Long Range Planning (LRP)</i>		1		<b>1</b>
<i>Technovation</i>	1			<b>1</b>
<i>Advances in Economics, Business and Management</i>			1	<b>1</b>
<i>Wall Street Journal</i>			1	<b>1</b>
<i>Bundesverband der deutschen Industrien (BDI)</i>		1		<b>1</b>
<i>Intern. Journal of CSR</i>			1	<b>1</b>
<i>Journal of Cleaner Production</i>	2			<b>2</b>
<i>Journal of Environmental Planning &amp; Management</i>	1			<b>1</b>
<i>Intern. Journal of Production Economics</i>	1		1	<b>2</b>
<i>Journal of Industrial Ecology</i>			1	<b>1</b>
<i>Journal of Innovation and Development</i>	1			<b>1</b>
<i>Global Economics Paper</i>	1			<b>1</b>
<i>Journal of Planning, Education &amp; Research</i>		1		<b>1</b>
<i>Business Insider</i>		1		<b>1</b>
<i>R&amp;D Management</i>	2		1	<b>3</b>
<i>International Journal of Technology Intelligence and Planning</i>		1		<b>1</b>
<i>Procedia CIRP</i>		1		<b>1</b>
<i>Technological Forecasting and Social Change</i>			1	<b>1</b>
<i>Research Institute of Economy</i>		1		<b>1</b>
<i>Journal of Sustainability</i>			2	<b>1</b>
<i>Journal of Corporate Responsibility and Leadership</i>		1		<b>1</b>
<i>Massachusetts Institute of Technology (MIT)</i>		2		<b>2</b>

<i>Journal of international Business Studies</i>		1		1
<i>Journal of international Entrepreneurship</i>		1		1
<i>Research Policy</i>	1			1
<i>The Edge Malaysia</i>			1	1
<i>European Journal of Innovation Management</i>	1			1
<b>Total</b>	<b>11</b>	<b>13</b>	<b>11</b>	<b>35</b>

Table 2: Other sources (Company reports, books, etc.)

<b>Source</b>	<b>Type</b>	<b>2001 – 2013</b>	<b>2014 – 2023</b>	<b>Total</b>
<i>McKinsey &amp; Company 2022</i>	Report		1	1
<i>Statista 2023</i>	Database		1	1
<i>Greenpeace 2018</i>	Website	1		1
<i>Nestlé 2023</i>	Press release		1	1
<i>Forbes 2021</i>	Website		1	1
<i>United Nations</i>	Website		1	1
<i>IPCC 2007</i>	Website	1		1
<i>Sustaining Industrial Competitiveness after the Crisis 2012</i>	Book	1		1
<i>BMW Group</i>	Press release		1	1
<i>VW Group</i>	Website		1	1
<i>Japan Industry News</i>	Press release		1	1
<i>Gartner Glossary</i>	Glossary		1	1
<i>Car@Tum</i>	Website		1	1
<i>B Lab Global</i>	Website		1	1
<i>Audi business innovation</i>	Website		1	1
<b>Total</b>				<b>15</b>

In this segment, the articles were examined that surfaced during the process of the journal selection. The aim is to pinpoint recurring themes within the literature and provide a status quo of published literature (See Table 1 & 2).

Table 3: Recurrent themes and theories in the literature

<b>Theories/Themes</b>	<b>Articles</b>	<b>Sub-Themes</b>
<b>Digital Transformation</b>	Urbinati, A., Chiaroni, D., Chiesa, V., & Frattini, F. (2020); Andersen, P., & Ross, J. (2016); Burchardt, C., & Maisch, B. (2019); Kapustina, L. V., Gaiterova, O., Agababae, Kondratenko, J., & Sidelnikova, P. (2021); Mahon, D. (2021, March 29); Roland Berger Strategy Consultants. (2015); Wentrup, R. (2016); <i>McKinsey &amp; Company</i> (2022); Westerman, G., Bonnet, D., and McAfee, A. (2014)	Industry 4.0, digitization, business model transformation, digital twins, Cloud computing, AI, ML, IoT, cybersecurity, AR, VR, Data Analytics
<b>Sustainability</b>	Altenburg, T., Bhasin, S., & Fischer, D. (2012); Cegliński, P., & Wiśniewska, A. (2017); Glavič, P., & Lukman, R. K. (2007); Hetterich, J., Bonnemeier, S., Pritzke, M., & Georgiadis, A. (2012); IPCC (2007); Staff, G. (2018, April 10); Chen, X., Despeisse, M., & Johansson, B. (2020)	CSR, B-corps, Consumer behavior, renewable energy, circular economy, Carbon neutrality, green supply chain, Eco-friendly
<b>Open Innovation</b>	Chesbrough, H. and Crowther, A. (2006); Huizingh, E. (2011); Ili, S., Albers, A., & Miller, S. (2010); Lazzarotti, V., Manzini, R., Pellegrini, L., & Pizzurno, E. (2013); Dahlander, L., & Gann, D. M. (2010); Inauen, M., & Schenker-Wicki, A. (n.d.), (2011)	Knowledge sharing, innovation challenges, platforms, networks, open-source collaborations, joint ventures, partnerships
<b>Interconnectivity of the megatrends</b>	Cavusgil, S.T. (2022); Kennedy, S., Whiteman, G., & Van den Ende, J. (2017); Motohashi, K. (2019); Sá, M. J., Santos, A. I., Serpa, S., & Miguel Ferreira, C. (2021); Wu, L., Sun, L., Chang, Q., Zhang, D., & Qi, P. (2022); Benetello, R. (2021)	Competitive advantage. Network effect, cross-industry collaboration,
<b>Performance/Strategy</b>	Brem, A., & Schuster, G. (2012); Brouthers, K. D., Geisser, K. D., &	Business Models, Vision, financial performance, market

	Rothlauf, F. (2016); Ó Neill, J., Lawson, S. and Purushothaman, R. (2004); Philbeck, T., & Davis, N. (2018); Writer, J. S. (2023, April 1)	share & position, Customer satisfaction & loyalty, risk management
<b>Automotive Industry</b>	Beier, G., Kiefer, J., & Knopf, J. (2022); Elliott, R., Rubin, R., & Francis, T. (202); Smith, D. (2019, April 19); Szász, L., Csíki, O., & Rácz, B. (2021); Thun, J.-H., & Hoenig, D. (2011); Wellbrock, W., Ludin, D., Röhrle, L. et al. (2020); Zapata, C., & Nieuwenhuis, P. (2010)	German car manufacturers, BMW, Mercedes, Audi, Porsche, competitive landscape, supply chain, brand reputation

Table 3 provides an overview of which article provides input for certain themes that will be discussed in the literature review.

## 2.2. Digital transformation in the German automotive industry

When digitization restructures a firm's business model, an organization is undertaking a digital transformation, this is defined as a radical rethinking of how an organization uses technology, people, and processes to fundamentally change business performance (Westermann et al., 2014). Technologies that are transforming business are, for example, all industry 4.0 related technologies, and the so-called SMAC (social, mobile, analytics, and cloud computing) technologies. A 2019 study by McKinsey has revealed, that 68 % of respondents view Industry 4.0 as a top strategic priority (McKinsey & Company, 2022), reshaping three strategic fields for firms. The first one is *connectivity*, this one will be boosted by a data overflow, computational power, and cloud technology. The second one is *analytics and intelligence*, here, machine learning and artificial intelligence are transforming key trends. Lastly, *advanced engineering* will redesign organizations with additive manufacturing such as 3D printing, renewable energy, and nanoparticles (McKinsey & Company, 2022).

These three critical strategic components hold particular significance for automotive manufacturers operating within a highly competitive market. In Germany, the emergence of new technological developments, such as electric vehicles as alternatives to traditional fuel-powered cars, has disrupted the market. This has introduced new competition for original equipment manufacturers (OEMs), with established companies like BMW, and Mercedes. Porsche and Volkswagen are part of the OEM landscape in the German automotive industry (Zapata & Nieuwenhuis, 2019). An OEM is the original producer of a vehicle's components,

these being identical to the parts used in producing the vehicle, making them an original supplier (Khartit, 2021). These are as likely to be threatened by competition from outside of Europe.

Tesla became the most valuable automotive company in 2021 globally with a value of 170 billion Euros (Elliott, 2021), overtaking Toyota after ten years, as seen in Figure 2 Germany is represented by four firms, amongst the most valuable car brands globally. However, the gap between Tesla & Toyota towards the following brands is significant (Statista, 2023).

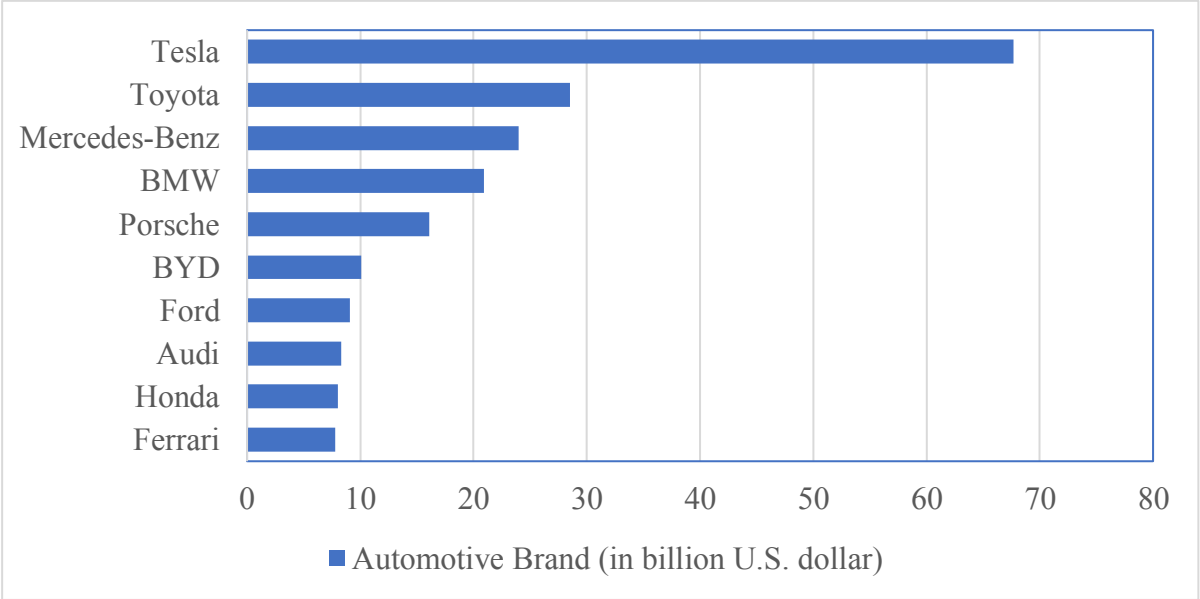


Figure 2: Most valuable car brands within the automotive sector worldwide as of 2023, by brand value (Statista, 2023)

China is pioneering electric cars through brands like BYD, NIO, and XPeng. Even the chairman of the board of management of Daimler AG, Dieter Zetsche, said:” Digital connectivity will continue to develop faster and faster. Today, you don't win the global competitive battle in the real world alone, but also in the digital one.” (Zetsche, 2015). Japanese automotive companies are at the forefront of exploiting digitization for their competitive advantage. They are heavily using digital twins to improve their product design, decrease their costs, and increase efficiency, especially in manufacturing. Digital twins are virtual replicas of the cars, which are used for simulation and analysis (Writer, 2023). In Germany, BMW and Mercedes are partially working with digital twins, but not on the operational level like their competition from Japan. Car makers and their supply systems in Germany are already in the process of transforming towards digitality. For example, through producing electric vehicles, improving digital services for greater customer experience and data analytics, or investing in autonomous driving with

vehicles from BMW or Audi. Moreover, BMW has committed itself to achieving at least 50% of its worldwide sales through electric vehicles by 2030 (BMW Group, 2022).

With rising competition from outside of Germany and societal standards changing, the automotive industry in Germany has to undergo a radical change from traditional business models to digital ones. Digital transformation is only one factor that drives the traditional key industry, which has been a symbol of wealth and progress for the last 120 years in Germany, towards a transformation phase that, if successful, has a place in a reshaped society. The chairman of the board of management at Audi AG states: “The digitization of society gives us as car makers the chance to make sure automobiles still have their place in cities of the future.” (Stadler, 2015).

### **2.3. Sustainability in the German automotive industry**

Sustainability is probably one of the keywords in the 21st century, more than ever this topic moves people. Through public figures and movements like Greta Thunberg and the Fridays for Future demonstrations, the Paris Climate Agreement, cradle-to-cradle designs, and a rising awareness of corporate social responsibility (CSR). People are demanding a more conscious way of living, especially younger generations, hence the customer base of the future. This is partially due to a finite amount of fossil resources driving oil prices higher, as well as new legal regulations which aim at controlling environmental pollution. These are factors that influence and change the requirements of customers and operations (Hetterich, et.al., 2012).

The definition of sustainability goes as follows:” Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs!” (Brundtland Report, 1987). This incorporates a society, where thoughts, ideas, and innovations benefit the whole. For organizations, this shift in customer demand, concludes a shift within their business models. Firms that incorporate their CSR within their business plans are often seen as having a competitive advantage in the market, as well as increasing customer trust (Cegliński & Wiśniewska, 2017).

Especially in an industry that uses fossil fuels like no other, sustainability is a frequently discussed topic, often due to corporate scandals such as electric batteries, lightweight construction, and CO2 emissions (Wellbrock, Ludin, Röhrle, et al., 2020). Glavic & Lukman have reviewed several sustainability terms of consumers and have identified that cleaner

production, pollution control, the minimization of resource usage, and eco-design are as important as ever before to customers (Glavic & Lukman, 2007). This shift in consumer demand has shaped the competitive landscape. The willingness to pay for renewable materials has risen (Bonnemeier, Pritzke, & Georgiadis, 2012) and automotive manufacturers face the challenge of adhering to political directives, internal standards, and evolving individual customer preferences (Thun & Hoenig, 2011). Here, a bridge can be built towards digitization, with the help of collecting and analysing big data, processes are improved drastically. Big data has the potential to improve corporate environmental protection and integrate sustainability into business processes (Beier, Kiefer, & Knopf 2022).

According to the Intergovernmental Panel on Climate Change (IPCC), a reduction in global greenhouse gas emissions to 50% of 1990 levels by 2050 is vital (IPCC, 2007). Recognizing that road transportation contributes to 16% of human-generated CO<sub>2</sub> emissions (OICA, 2010), it emerges as a crucial target for initiatives addressing climate change. The market is disturbed by the shift from conventional, fossil fuel-dependent transportation systems to e-mobility and car-sharing platforms. Numerous countries have recently introduced policy measures to encourage the adoption of electromobility. This pattern is projected to persist, particularly as the middle classes in populous BRIC countries continue to grow (O'Neil et al., 2004). When having a closer look at what the competition of the German car industry has achieved, one can identify that Germany is playing amongst countries like France, the U.S., Japan, and China to compete but not leading organizational change. For instance, France introduced “The Pacte automobile” in 2009, as a counteraction to the economic crisis, this is a multi-billion rescue package specific for the French automotive industry with bundled agreed support for electric vehicles as well as financial support for R&D (Presidente de la Ré<sup>’</sup>publique, 2009). In China on the other hand, at least six cities provide (Shanghai, Changchun, Shenzhen, Hangzhou, Hefei, and Beijing) purchasing subsidies for private electric vehicles to their citizens (Altenburg, Bhasin, Fischer, 2012). To illustrate, German automotive firms have partly relied on their traditional and luxury segments shows when having a look at the release dates of mass-manufactured battery-electric vehicles. Here, brands like BMW or Opel were two years behind French brands and four years behind Japanese car manufacturers (Szasz, Csiki & Rácz, 2021). On the other side, is the German car industry highly regulated, especially through recent scandals with emission standard violations, etc. The German government has an additional carbon tax on fossil fuels, making it lucrative for OEMs to produce electric cars. One can derive, that the industry is still resonating with significant sustainability challenges. German OEMs

must lower emissions per vehicle across all categories while simultaneously creating a substantial number of low-emission cars. This is to offset the emissions from the traditional luxury cars in their portfolio that are not likely to meet the mandated limits (Szasz, Csiki & Rácz, 2021).

The authors identify three categories of external pressure that hit the automotive industry and demand a new strategic choice in terms of sustainability. Firstly, they describe *normative pressure*, coming from customers, suppliers, and partners. These are in direct contact with the company and might as well identify themselves with it. For this group of stakeholders, the brand image is a key selling or engaging factor. Then, *imitative pressure arises* from competitors and is the direct comparison to other firms in the market. Lastly, *regulative pressure* is the legal requirements that a firm needs to meet to operate. Given the significant reliance on resources, the automotive industry is compelled to address all three categories of pressure toward greater sustainability (Szasz, Csiki & Rácz, 2021).

#### **2.4. Open innovation in the German automotive industry**

As mentioned above, consumer demand has shifted in the past decade, due to new technologies and coming opportunities, as well as climate change awareness and the need for solutions and new ways of operating. The market has shifted from the classic develop, build, and sell market towards one, where brands are successful if they identify a customer need before the customer does (Steve Jobs, 2019). In the past, OEMs have invested in their R&D as the key innovation driver to stay innovative and competitive. Nowadays, with global competition, German car manufacturers are experiencing higher innovation and cost pressure. To stay competitive, several OEMs decide to look outside their boundaries to acquire new knowledge (Ili, Albers & Miller, 2010).

The widely accepted definition of open innovation goes as follows:” The use of purposive inflows and outflows of knowledge to accelerate internal innovation, and to expand the markets for external use of innovation, respectively” (Chesbrough et al., 2006). It stands out, that in times of crisis, firms are more than ever overthinking their business models. During the COVID-19 pandemic, several firms hired consultancies to transform themselves. These new forms of innovation-seeking can result in new partnerships, outsourcing, strategic alliances, R&D corporations, etc. (Inauen, Schenker-Wicki, 2011). Knowledge sharing often results in advantages such as reducing or sharing one’s R&D cost and time, as well as enhancing idea

generation. However, besides these direct advantages, other factors are moving firms towards open innovation, these being customers and globalization (Lazzarotti, et al. 2013). Since competition is increasing with brands outside of Europe, customers are in a comfortable position to demand more from their products and services for the same price. This in combination with stricter environmental guidelines, safer data protection laws, and safety conditions, leads to an increase in pressure for traditional OEMs to innovate and adapt (Lazzarotti, et al. 2013).

German car manufacturers are, to a certain extent, already making use of open innovation. For example, BMW adopted a “Virtual Innovation Agency” (Bmwgroup, 2023) that oversees the innovation circle across BMW and Volkswagen (VW) launched an online-based interface where engineers can contribute their ideas from all over the globe and offer several innovation contests. One of these is “Porsche Next-OI”, where the winner is offered a corporation with Porsche for their idea (Volkswagengroup, 2023). These are examples of increased idea generation through open innovation. It is to be noted, that Germany is here not the leading force globally, but steadily adopting open innovation. In Japan, the US, and China, likely methods are used. For instance, did Ford cooperate during the Covid-19 pandemic with 3M to fasten the production of ventilators for healthcare workers, the production lines of cars were able to produce faster than the original ones from 3M (Ford, 2020). Resulting, in new revenue streams for both firms and a greater social benefit.

## **2.5. Interconnectivity of megatrends to the German car industry**

After having provided the fundamental knowledge of the megatrends and their influence on the German automotive industry, the current status quo and the perception of their importance within Germany, the automotive industry, and their interconnectivity will be reviewed in the upcoming part. This aims to provide an overview of the interdependencies, how they push or drawback each other, and if the German car industry can benefit from their interplay.

First, we are examining the relationship between open innovation and digitization. These two are rarely separated within corporations. Digitalization not only enables the open innovation process, but also the way one works, it opens cultures towards each other and allows connectivity for MNEs. For example, co-working spaces like WeWork, The Factory, or home office have emerged, and technical tools are giving us access to one another in an increased speed and quality dimension (Teams, WhatsApp, Slack, Dropbox, etc.) (Burchardt & Maisch,

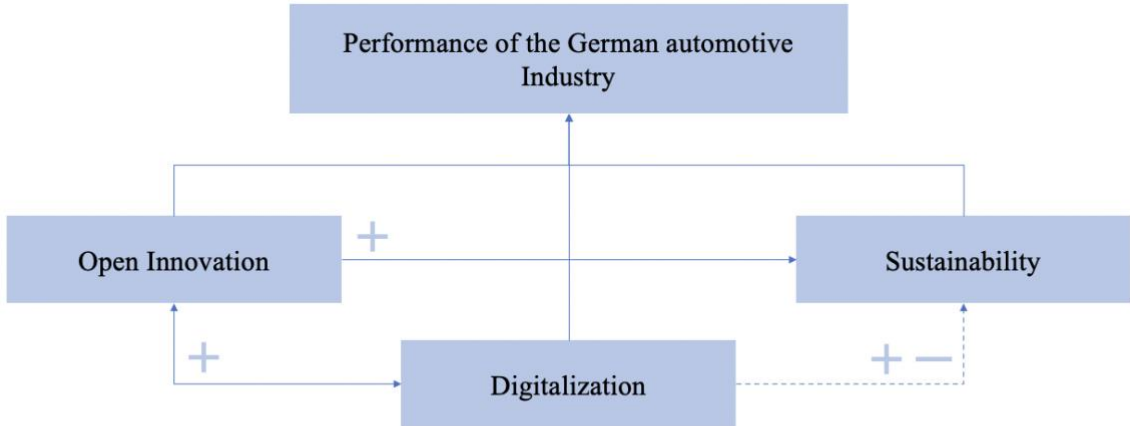
2019). Hence, it is reasonable to open the innovation process under digital tools and techniques to move away from the traditional innovation process, where teams work in silos and struggle with efficient use of resources, and closed knowledge. One can derive that open innovation is enabled through digitalization, and can act as a source of competitive advantage (Wu et. Al, 2022). Furthermore, it gives the possibility of greater resource usage, capturing more knowledge, and fastening processes (Urbinati, Chiaroni, Chiesa & Frattini, 2020). On the other side, open innovation does as well influence positively digitalization. Through collaborative knowledge sharing, idea generation is enhanced. For example, between software developers, open innovation is largely used to share knowledge and derive faster at a desired solution. These open innovation processes can take on various forms, Motohashi mentions in his research that companies can benefit tremendously from it if it takes place between all stakeholders, customers, suppliers, universities, and even competitors. Hence, not only the speed of the innovation process is widened but also the scope. In the car industry, one can see a shift within industry lines by emerging services such as car-sharing apps. These are constantly sourcing new data for innovation and becoming a better version of themselves (Motohashi, 2019). One can derive, that these two megatrends are positively influencing each other.

Secondly, we are shifting our minds towards the relationship between sustainability and digitalization, often referred to as digitainability (Sá et al., 2021). Here, the literature points out the importance of calculating the costs and benefits of the relationship between these megatrends. On the one hand, digitalization can increase firms' sustainability performance by allocating resources as efficiently as possible with industry 4.0 tools and technologies, and offer greater information and knowledge sharing across organizations. On the other hand, are these digital solutions high in their energy consumption, and the with coming carbon footprint increase. Additionally, the use and disposal of the hardware are discussed widely, since the product lifecycle is shorter, better versions arise and will substitute older ones due to efficiency reasons. These are difficult to recycle (Chen, Despeisse & Johansson, 2020). On the other hand, digital services are often used to analyse driving performance behaviour and optimize it to reduce emissions and energy. Here, customers get transparency about how ecologically sustainable they are behaving and can adjust their behaviour. Even though the relationship between digitalization towards sustainability is seen as positive and negative, the megatrend sustainability does not influence digitization to a greater extent (Seele & Lock, 2017).

Lastly, we are conducting the relationship between sustainability and open innovation. These two megatrends are often combined and referred to as sustainability-oriented innovation (SOI) and are seen to be the root of competitive advantage. It is defined as: “realized ideas that improve environmental and/or social performance compared with the current situation”. (Kennedy, Whitemann & van den Ende, 2017). Firms are more than ever incorporating sustainability and CSR into their business models. For example, Patagonia is a certified B-corporation with the mission to cause no unnecessary harm and implement solutions to sustainability issues (Bcorporation, 2023). Being a sustainable company became their competitive advantage, Patagonia is globally known and makes their sales based on their sustainable business model. Here, open innovation is the key driver influencing sustainability issues positively by sourcing solutions from a variety of sources.

Sustainability goals are often implemented through open innovation in the German automotive industry. As a traditional industry, input from outside firms can contribute to acting more sustainably. BMW formed a joint venture with students from the Technische Universität München (TUM) to evaluate ideas for greener cars and manufacturing processes (Car@Tum, 2023) and Audi has established the Audi Business Innovation hub, where digital product development and IT expertise form new sustainable and user-centric solutions (Audi, 2023).

**2.6. Interdependencies of megatrends on the German automotive industry**



Agenda:  
 — Positive relationship  
 - - - Positive and negative relationship

Figure 3: Relationships between the megatrends

As the preceding analysis shows, based on the literature review, all three megatrends have relationships with each other, influencing the performance of the German automotive industry.

Figure 3, visualizes these relationships and their positive or negative influences. Foremost, one can derive that all megatrends are correlated somehow and shape each other's landscapes. The variable "Performance of the German automotive industry" acts as the dependent variable, its outcome is shaped by the independent variables. These are the megatrends, "Open Innovation", "Digitization", and "Sustainability". The drawn line represents a positive influence between the given variables and the dotted line portrays the possibility of a positive and/or negative relationship between these variables. This is the case between the independent variables of sustainability and digitization, as described above digitization solves efficient resource allocation but brings along other concerns for firms. On the other side, open innovation and digitization have a positive influence on each other, enhancing their performances.

Figure 3 serves as a visualization of the established relationships and theories retrieved from the literature review. It will act as a basis for the exploratory interviews. Here, participants will be chosen based on their interaction with the German automotive industry, to gain professional industry insights and confirm or deny the established relationships of Figure 3, with the influence of the three megatrends on the German automotive industry.

### 3. METHODOLOGY

To ensure a credible answer to the problem statement: “Will the German automotive industry be able to compete, survive, and reproduce under the megatrends of sustainability, digital transformation, and open innovation?” and it’s with coming research questions, the following chapter will provide a detailed research design and further explain the data collection process. The detailed description of the used methodology will provide a further understanding of the research results, as well as inspire and guide future researchers to follow up on the influence of megatrends on the German automotive industry. Thereby offering greater transparency on the used approach and gained results. Lastly, a critical reflection of the quality and methods provided will follow, to ensure reliable results.

#### 3.1. The Research Design

This paper follows an academic dissertation approach with a qualitative research strategy to prove the interconnection of sustainability, digital transformation, and open innovation and its impact on the German automotive industry. The German automotive industry generates for a total revenue of 410.9 billion euros, with 274 billion euros generated in foreign markets (GTAI, 2023). Therefore, this paper will focus on the top-tier players of the German automotive industry and its competition from China, the U.S., and Japan. To answer the problem statement, a deep literature review on the status quo and possible threats and opportunities is conducted, as well as additional exploratory research with expert interviews to further strengthen the findings. The acquired knowledge widens on a cross-sectional time frame to one specific industry. The combination of secondary and primary data aims to fill the research gap and guide further research in this field.

The reasoning for choosing the German automotive industry as the playing field of the academic dissertation relies on several justifications. First of all, while skimming the megatrends, I have noticed that the research on the interplay of these is scarce in the German automotive industry. Most articles have examined the influence of only one megatrend. Secondly, I am interested in the automotive sector and how it will evolve, through professional experience as a student consultant at Capgemini Invent in the automotive sector and personal interests. There, significance of megatrends and the threats of other countries toward the German automotive industry was noticed. Familiarity with the topic, personal interest, professional experience,

existing contacts for the expert interviews and the need to develop a richer understanding of the interplay, are motives for choosing the German automotive industry and the influence of megatrends as the focus. Lastly, the automotive sector is an important industry for Germany and does provide income to many Germans. With 3.1 million passenger cars produced in 2021, Germany is Europe's leading production site and the automotive industry serves as a backbone for the country (Germany Trade & Invest, 2021), therefore a shift would influence the country and society as a whole. The results aim to deliver valuable knowledge for people of interest and decision-makers within the automotive industry, as well as provide a reasonable outlook for the future.

The research will follow a qualitative approach, with a deep contextual understanding through a literature review, and exploratory research through expert interviews. Qualitative research is extremely advantageous when investigating complex topics in untouched areas, but has the drawback of never being fully neutral, since researchers are not able to fully separate themselves while investigating (Clarke & Jack, 1998). This bias is overcome with the primary data collection through expert interviews in this field.

The literature review begins by laying a foundation of knowledge and evaluating existing literature. Table 1 & Table 2 lay out a holistic understanding of used articles and journals. It focuses on the top-tier players of the German automotive industry as well as the strongest competing countries, China, the U.S., and Japan. A definition of each megatrend is provided, with additionally a few examples of how these are applied currently.

The above-described research design builds the framework of the used approach in this paper. The detailed process will be described in the following section. The methodology part will provide a holistic view of the used approach and offer transparency for upcoming researchers.

### **3.2. The Research Process**

This paper follows a two-phased approach. First, a knowledge base is laid out by scanning existing literature and providing a literature review with several examples of the present status quo. Then, primary data is collected through expert semi-structured interviews.

### 3.2.1. Secondary Data

As mentioned above, the scope is defined and the existing literature is investigated on the research topic. It starts by sorting the theory, developing the first concept, and assuming relationships between the megatrends (Figure 3). The journal selection (Table 1 & Table 2) provides an overview of the sources and describes the evaluation of these articles, as well as their limitations. Most of the articles taken are from 2013 until the present (Table 1), to provide accurate knowledge, however, some are from a later stage, providing a cross-sectional time frame of knowledge within one industry and one country. Additionally, to articles, a diversity of sources is given by books, statistics, company reports, and professional work experience, resulting in multiple approaches for secondary data collection.

### 3.2.2. Primary Data

The primary data collection will be conducted through semi-structured interviews (SSIs), answered by nine experts from the automotive industry. The interview questions are based on Figure 3, which describes the relationships of the megatrends based on the literature review. The expert interviews follow a semi-structured method because room is needed for open-end questions to gain professional insights into the automotive industry, as well as probing and follow-up questions to evaluate Figure 3 appropriately (Adams, 2015). Therefore, the interview questionnaire acts as a guideline for the interviews, allowing natural conversations and statements to occur. A disadvantage of SSIs is, that the sample size is not as large as for surveys, however, to answer the problem statement, expert opinions are needed and these are time-consuming and not easily accessible. Generally, should sample sizes in qualitative research not be too small to make it challenging to achieve data saturation but as well not too large to make it too complex to manage the acquired data (Onwuegbuzie and Collins, 2007). The sample of respondents was chosen based on the criteria, that each participant would contribute necessary knowledge and accessibility, and have an interaction with the German automotive industry (Appendix: 7.2. Participants). Diversity is granted through age, gender, professional experience levels, and personal interaction with automotive brands of participants. Some participants are consultants, working professionals at car firms, professors teaching at Católica Lisbon School of Economics and Business, etc. The interview guideline (Appendix:

7.1. Semi-structured **interview-guide**) follows a set of questions that aim to answer the four research questions and the overall problem statement. All nine interviews were transcribed and their empirical findings were discussed, summarized, analysed, and connected to the literature review. Further explanation of the data collection will follow. The interviewees will be held anonymous in this research paper due to the confidentiality of industry insights and professional experience.

After collecting primary and secondary data, the findings are discussed and analysed. Lastly, the research findings will provide an answer to the problem statement and provide managerial decision-making knowledge. To visualize the research process of this paper, Figure 4 will provide further closure:

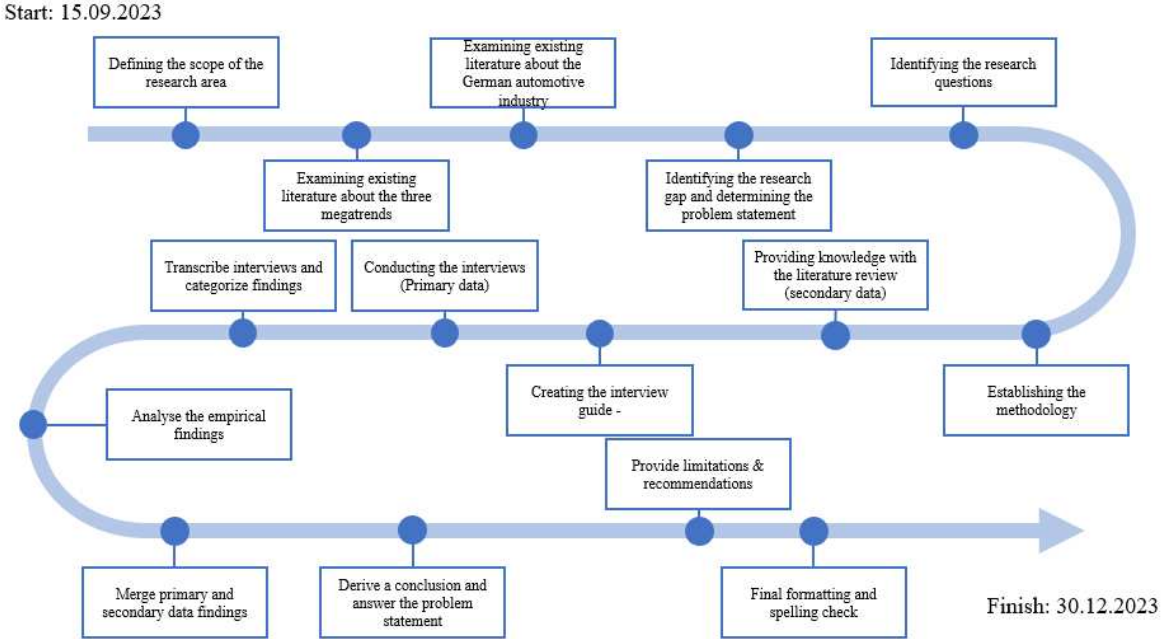


Figure 4: Timeline of the qualitative research paper

**3.3. Data Analysis**

First and foremost, the theoretical and empirical data are analysed with an iterative approach, meaning they are constantly revised and, if applicable, modified. The raw data was designed in a way that the questions are clustered around sub-themes. After all interviews had been transcribed, obvious flaws or non-answered categories and questions were sorted out. The answers within these clusters were then categorized to discover patterns and irregularities. Coding of text is a process where the data is broken down into parts, which are then labelled

for categories (Bell et al., 2019). This paper categorizes the megatrends, the interplay and the impact on the German automotive industry. The text is coloured according to the categorized answers. Here, special emphasis lies on recurrences of sequences within the coded text and links between the answers or towards the theory founded in the literature review. Through the thematic analysis, the data was reduced and significant linkages became transparent. These result in valuable statements, that together with the accomplished theory from the literature review, discuss the research questions.

### **3.4. The Research Quality**

An interviewing process with great quality gives a larger coverage of the focus topic and enables the researcher to maintain and dig deeper into the specific focus (Bell et al., 2019). One alternative criterion to the quantitative measures of reliability and validity, to evaluate the quality of the research, is offered by Lincoln and Guba (1994), they state the two dimensions of trustworthiness and authenticity (Guba and Lincoln, 1994). These are broken down into four criteria: *credibility, transferability, dependability, and confirmability*.

*Credibility* can be measured through “triangulation”, which refers to using more than one source of data while researching a given problem statement (Bell et al., 2019). This paper is conducting a two-phased structure approach with primary and secondary data collection to analysis the problem statement.

*Transferability* is not typical for qualitative studies; they tend to investigate a narrowed focus topic and interview a smaller group of experts within that field. However, qualitative studies can ensure transferability in a detailed description of their process. The future researcher is then able to judge precisely, the relevance of this study to their approach (Bell et al., 2019). The methodology part of this study covers a detailed description of the applied process.

*Dependability* entails the storage of all data gathered during the process. This paper offers an appendix with all relevant additional information. As well can the author be contacted for further investigation. Contact details can be found in the appendix.

*Conformability* to prove, that the acquired theory from the literature review is not objective to the researchers’ personal preferences, the expert interviews have been conducted to support or disagree with the existing assumption of the theory.

## 4. DISCUSSION OF RESEARCH FINDINGS

The analysis of the expert interviews and the with coming discussion of the theory conducted in the literature review aims to answer the four research questions. Leading towards an answer to the overall problem statement of:

*Will the German automotive industry be able to compete, survive, and reproduce under the megatrends of sustainability, digital transformation, and open innovation?*

The discussion will be categorized as the literature review and the interview guide, towards the subjects of the research questions.

### 4.1. Analyse the findings

#### 4.1.1. Digital Transformation

Beginning with the first research question:

*How does digital transformation influence the German automotive industry?*

Within the expert interviews, seven out of nine people value digital transformation as the number one choice when prioritizing strategically for German automotive firms. This aligns with the findings in the McKinsey & Company report of the literature review, considering industry 4.0 elements as a top strategic priority (McKinsey & Company, 2022).

German automotive firms are under high cost and margin pressure, therefore constantly streamlining processes and trying to become more efficient, here digitization is a vital factor (Participant #3). Consequently, digitization is important not only for the car itself, but as a whole in the engineering, manufacturing, and selling processes, new technologies will transform the way automotive firms operate (Participant #3). Currently, the interviewed professionals still experience, that German automotive firms invest the most in digital transformation, but as well that it is the toughest one to implement. For most of the traditional car brands in Germany, projects include the implementation of basic digital services, for instance, appointment scheduling. The explanation here lies most of the time in the size of traditional companies. The larger a firm is, the longer it will take to transform digitally. For example, the distribution unit

of VW Germany consists of 300+ sub-units, one can only imagine how much it would cost to digitalize and upskill all of them (Participant #7). This one initial investment would be more beneficial in terms of transformation and financial outcome, but firms are hesitant to invest large sums at once. In consequence, firms only transform partly and are missing out on important interfaces within the company. Slowing down their transformation process and mitigating their chances of a successful digital transformation (Participant #5).

The expert interviews highlight the importance of change management during digital transformation, seven out of nine participants, define the training and upskilling of employees as a vital part of digital transformation. The need to shift mindsets and get employees used to new ways of operating is essential. In traditional firms, especially older employees might struggle or are even resistant to change (Participant #1). This skill gap can be filled through careful step-by-step implementation and a roadmap of change management. If implemented successfully, digitization has a direct positive effect on employees, customers, and financial return. In contrast to sustainability, this is a major motive for people to implement digital projects as a priority (Participant #4).

Theory from the literature review has revealed, that German automotive firms are especially threatened by competition from China, the U.S., and Japan. For example, is Tesla the most valuable car brand in 2023 (Statista, 2023) and Japanese firms are heavily using digital innovations for predictive maintenance and performance increase. The professionals have disclosed, that German car companies still tend to give too much focus on engineering and manufacturing and not enough on software & computer development within the car. Comparing the driving experience of a Chinese NIO car to a German car, one can point out several significant differences. To illustrate, NIO cars have little physical robots in their cars, called Nomi who are AI-assistants, talking to the driver and helping them with navigation, etc. At the IAA 2023 in Munich, the biggest key takeaway was that Chinese and Japanese firms built their cars like smartphones and set their focus on digital services and entertainment, while German brands tend to rely on their success in engineering (Participant #3). Paying closer attention to competition from the U.S., one can determine that traditional brands like General Motors (GM) or Ford are falling behind further. They are focusing on the satisfaction of their current customer base and are not heavily investing in innovations or new services. The U.S. market is split between traditional firms and new entrants and digital natives such as Tesla or Uber (Participant #4). In comparison, Germany's traditional automotive firms are being more innovative. BMW

created the “BMW Start-up Garage” a BMW accelerator to find solutions for internal processes (Participant #6). Many German brands have founded accelerators to boost and digitalize internal and external processes.

#### 4.1.2. Sustainability

Continuing with the second research question:

*How does sustainability influence the German automotive industry?*

In terms of strategic prioritization for German automotive firms, sustainability was ranked last between open innovation and digital transformation, by almost 67% of participants. For the reasoning, that sustainability is a driving source of cost and does not offer an immediate financial return (Participant #8), therefore it is not central to most decision processes of firms. In addition to that, one has to bear in mind, that the cycle to produce a new model of cars roughly takes seven years, going from idea creation to engineering, design, etc. To make cars more sustainable, the train of thought needs to arrive years before the car hits the market (Participant #4). After the VW scandal in 2015, currently, almost 8 years later we are seeing a boost in electric cars and a shift in the minds of automotive firms (Participant #3). Additionally, VW is just now building a Gigafactory to produce electric cars and their batteries within Germany (Participant #7).

The literature review discussed the points of normative, imitative, and regulative pressure on automotive firms toward sustainability (Szasz, Csiki & Rácz, 2021). In terms of normative pressure, it is highlighted that the willingness to pay for renewable materials has risen (Bonnemeier, Pritzke, & Georgiadis, 2012) and that cleaner production, pollution control, and the minimization of resource usage are as important as never before to customers (Glavic & Lukman, 2007). Within the expert interviews, it was identified that the demand and focus on electric vehicles were rising at the beginning of the century, mainly driven by sustainability concerns (Participant #1). On the other side, do firms notice, that within projects sustainability is rarely the main focus. It is most of the time sold as an add-on, on top within projects, but not the unique selling point. Sustainability rarely takes a priority stand in the eyes of customers in Germany, only if they are certain that they don't have to sacrifice performance (Participants #4 & #7).

Moving to imitative pressure, which arises through competition in the market, the expert interviews have identified that sustainability in the German automotive industry is often not used as a competitive advantage due to its longer times of return, financially and reputationally (Participant #8). Especially, traditional German automotive firms are building on their foundation of providing excellent engineering as a competitive advantage. Shifting to competition from China or the USA, sustainability is less a topic of prioritization than in Germany. Most of the time, it does not play a crucial role in strategic making processes (Participant #7). In Germany, on the other side, automotive firms are paying closer attention to a green supply chain. For example, BMW Start-up Garage, an accelerator from BMW roughly conducts 50% of their start-up's evaluation only towards sustainable firms and sustainable solutions. Trying to develop and educate themselves internally and externally, toward a more conscious way of competing in the industry (Participant #6). Firms in Europe are forced to act greener, having to obey legal requirements by the government.

Leading to the last form of regulative pressure, almost all participants have mentioned, that in comparison to competition from other countries, Europe has stricter regulations towards acting sustainable. China might be producing and selling more electric vehicles, but in Germany the whole supply chain process is more regulated towards environmental protection, hence acting greener (Participant #4). On the other side, these sustainable regulations include higher costs and technological limitations, leading to higher barriers for automotive firms from Europe in comparison to their competition from outside of Europe (Participant #2). Therefore, consultants have experienced, that German automotive firms integrate sustainability to the degree, that all legal regulations are fulfilled. If it goes beyond that point, most German automotive brands hesitate to invest further, since the direct financial return is missing.

#### 4.1.3 Open Innovation

Moving to research question number three:

*How does open innovation influence the German automotive industry?*

The exploratory interviews reveal, that open innovation is seen by all participants as important, but never as the most pivotal point to implement strategically. Additionally, six out of nine participants mention, that open innovation is enhancing other megatrends and rarely brings any harm to firms. The frequently referred forms of open innovation in the German automotive industry are collaboration, partnerships, crowdsourcing, platform idea facilitating, and

cooperation to for example universities, etc. (Participant #2). The literature review has established, that the German automotive industry mostly invests in its R&D as a key innovation driver and is rather apprehensive to share their knowledge. This was confirmed by four out of nine interviewed participants. Especially, German firms are often scared of resource and capability sharing and therefore leave the innovation process within internal boundaries (Participants #5 & #4). On the contrary, have several named industry insights of German automotive firms using open innovation. In general, OEMs have opened their knowledge hubs and started collaborative work, especially due to their lack of knowledge and the help with the implementation of new technologies or ways of working. For instance, there are a lot of car firms implementing Google Car Play and therefore partnering up with Google. Here, their benefit is, that customers are already familiar with Google, and Google car play is already developed, tested, and established. A car manufacturer would not be able to produce something similar in a short amount of time. This holds, especially in fields of everything-as-a-service, gamification, and generative AI-related features (Participant #7). For these services and features, investing or collaborating with start-ups is used as a source for idea generating (Participants #2 & #9) or involving customers in the idea creation and evolution with their feedback (Participant #4).

The literature review exhibits that enhancing idea generation is one of the greatest benefits of open innovation, and the exploratory interviews do support this and name several beneficial examples. In consultancies, partnerships are often used for knowledge sharing and the education of consultants. This process can be transferred to automotive firms as well, here open innovation provides access to a broader range of ideas, accelerates product development, and fosters a culture of continuous improvement (Participant #2). It was widely agreed, that firms mainly benefit from open innovation, the greater the knowledge, the greater the idea creation. However, operational challenges may arise (Participant #8).

Open innovation can be applied in the whole supply chain, especially with other industries that might be steps ahead in terms of applying the megatrends. Suppliers can be heavily involved in the innovation process and contribute (Participant #5). Partnerships are a strong force against competition, for example, BMW, Ford, Hyundai, Mercedes-Benz, VW, Audi, and Porsche created the joint venture “Ionia”. Together they are building a European network for electric charging stations and want jointly face competition from outside of Europe (Ionia, 2023).

The literature review discusses, that the German automotive industry is not a leader in open innovation but can keep up with competition. China has the advantage of fewer data restrictions; therefore, operational barriers are not as high as in Europe (Participant #8). Additionally, traditional German automotive firms are old-fashioned, and every change request needs to undergo approvals within the organization, this is time and resource-consuming (Participant #9). Therefore, some new input from outside could broaden the horizon and push idea generation and competitiveness. However, as mentioned in the literature review, the German automotive industry is undertaking a few open innovation approaches. For example, cooperation with universities and innovation challenges are often used, as well as feedback generated from customers. Joint ventures are becoming more popular amongst traditional German car brands. The European Union founded Catena-X, with the vision to connect the automotive industry via a global data space to solve industry problems jointly. Here, participants are amongst others Siemens, Bosch, IBM, Autorecycling, Mercedes-Benz, Microsoft, Ford, SAP, VW, AAI (automotive artificial intelligence), and Volvo (Catena X, 2023). The chairman of the Board of Daimler AG and Mercedes-Benz AG, Ola Källenius states:” With Catena-X, the automotive industry is taking another big step in its digital transformation. The aim is to achieve secure data transfer between companies to enhance efficiency, transparency, and sustainability along the entire value chain.” (Ola Källenius, 2023). Here, it shows how open innovation acts as an enabler for other megatrends, such as digital transformation, and that data security is an immense challenge within Europe.

#### 4.1.4. The interplay of the megatrends

Lastly, the last research question is discussed:

*How do sustainability, digital transformation and, open innovation interplay amongst each other in the German automotive industry?*

The second part of the semi-structured interviews focused on the interplays of the megatrends and their influence on the German automotive industry. The literature review revealed, that all megatrends are correlated and have an impact on the German automotive industry (Figure 3). As displayed in Figure 3, the theory assumes that open innovation has a positive influence on sustainability and digital transformation, that digital transformation and sustainability are positively and negatively related and lastly that sustainability does most of the time not act as an enabler for other megatrends. In the following section, the theory will be discussed according to the exploratory interviews.

### *Open Innovation and Sustainability*

These two megatrends have a positive relationship with each other, according to Figure 3, the experts have argued that open innovation acts as an enabler for sustainability solutions, while sustainability can be the driving source. Hence, they reinforce each other and facilitate the exchange of ideas (Participant #2). This aligns with the findings from our literature review. Open innovation is an accelerator for the development of sustainable efforts. To illustrate, BMW Start-up Garage launched a 360-degree sustainability challenge for sustainable and innovative solutions. The winners were given the chance to present their findings at the IAA in Munich, in 2022 and gained funding by BMW to kickstart their idea. Here, BMW benefits from creative solutions and the creators gain funding and a network to operate further. Advantages are created for all parties (Participant #6). The findings from the expert interviews do as well support the argument, that open innovation has a direct effect on sustainability, however even though sustainability can be a driver to undertake more open innovation, it does not act as an enabler towards open innovation. Therefore, the influence is positive from open innovation towards sustainability.

### *Open Innovation and Digital Transformation*

From the literature review, one can derive that open innovation and digitization are both enablers for each other. Consequently, their relationship is seen to be positive. The expert interviews have confirmed this. Digital platforms are facilitators of open innovation, providing channels for collaboration, idea-sharing, and co-creation (Participant #2). Consequently, the more knowledge, the more ideas are created, and new ideas on how to implement and use digitization arise (Participant #8).

### *Digital Transformation and Sustainability*

The relationship between sustainability and digitization is unique in a sense, that the respondents and literature theory have contradictory views about it. Some argue, that it is a positive one since digitization practices are more environmentally cautious, others say that it drives CO<sub>2</sub> emissions due to higher energy consumption. Either way, the theory from the literature review, as well as the expert interviews, have shown, that digital transformation and big data have the potential to improve environmental protection and integrate sustainability into business processes (Beier, Kiefer, & Knopf 2022) (Participant #1 & #9). The impact of sustainability towards digitalization is not as high, again it acts as a source of idea creation but

not as an enabler. The experts have revealed several benefits, resulting from digitalization, towards environmental practices. For example, the optimization of resource usage within the supply chain of cars, monitoring the environmental impact and adjusting accordingly, enabling the development of more eco-friendly products and predictive maintenance in the production process (Participants #2, #6 & #9).

During the exploratory interviews, each category was opened with a ranking question, this being:” On a scale from one to ten (One being the lowest and ten being the highest), how do you value (Insert megatrend) for strategic decision-making in the German automotive industry.” In Figure 5, the results are displayed:

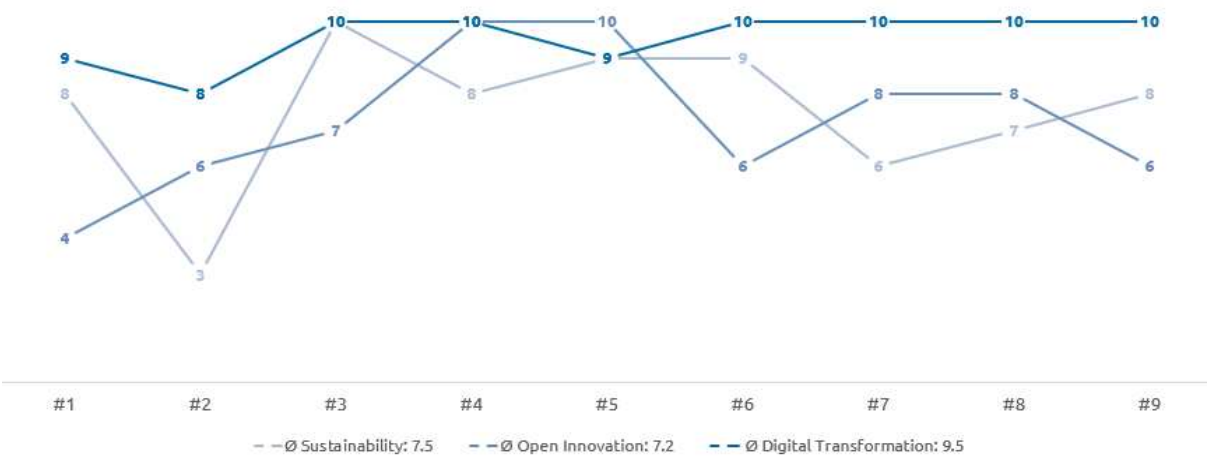


Figure 5: Responce of strategically relevance of the megatrends by the interviewed experts

First and foremost, these entry questions show, that all participants value the three megatrends as important in strategic decision-making in the German automotive industry. The lowest average reaches open innovation with 7.2 and the highest digital transformation with 9.5, therefore none of them is seen as irrelevant and can be stated as megatrends, which will be long-lasting with a remarkable impact. It is visible, that digital transformation is seen as the most valuable megatrend to firms in the automotive industry, it was selected with the highest ranking of ten by seven out of nine participants. It is striking, that people who value digital transformation as the most valuable, do as well rank sustainability as the least important. Here, it was argued that sustainability should be focused on least since it is highly regulated by the government and will be dragged along when focusing on the other megatrends (Participant #4). Additionally, sustainability does not result in a direct financial return and does therefore not lie in the first interests of either supplier or customer (Participant #7). Digital transformation on

the other side, is seen as the backbone of the century and a must-have for firms to thrive against competition. In addition, does it enable the implementation of sustainable practices and open innovation. For instance, collaborations between automakers and younger tech companies are winning in developing sustainable, connected, and technologically advanced vehicle features (Participant #2). In the same vein, both sustainability and digitalization are demanded to a certain degree by customers and can both be enhanced through open innovation (Participant #5). For this reason, other participants value open innovation as the most important when making strategic decisions in the German automotive industry. It enables other megatrends and is constantly thriving towards new growth (Participant #4).

## **4.2. Impact on the German automotive Industry and future outlook**

To finalize the analysis of the German automotive industry under the influence of the megatrends, the theory from the literature review and the findings of the exploratory interviews will be investigated by a strength, weaknesses, opportunities and threats (SWOT) analysis. A SWOT analysis measures the fit of a strategic term, in our case the megatrends towards internal qualities (strength & weaknesses) and the external fit (opportunities & threats) (Hill & Westbrook, 1997). Internal qualities will be conducted on the German automotive industry and external fit towards its competitive competition with China, the U.S., and Japan.

### **4.2.1. Strength**

The German automotive industry has, due to its traditional standing, a very strong and loyal customer base and global recognition. Due to its strict sustainability regulations, they act greener throughout the whole supply chain as competition from China, the U.S., or Japan. If customers value fair wages and environmentally cautious production, Germany has an advantage over the competition. Due to the enormous size of the automotive firms in Germany, it is tougher to implement open innovation and digital transformation, however, corporations and start-ups have shown, that Germany has brilliant heads to offer, which could thrive if correctly taken care of. Lastly, Germany is an economically strong country with strong neighbouring industries that partner up with automotive firms to share knowledge, and foster digitalization, and open innovation.

#### 4.2.2. Weaknesses

Due to the larger size of most German automotive firms, it is difficult to implement change, therefore megatrends are often not implemented to their full potential (Participant #3). In light of this, processes have been consistent, not adapting to new industrial trends. Moreover, in their strategic decision-making, German automotive firms tend to act conservatively and non-risk taking in their decision-making. Here, in open innovation, the possible threats of knowledge sharing stop firms from actively participating (Participant #5).

#### 4.2.3. Opportunities

The German automotive industry has many opportunities to engage in these megatrends since they are well established, connected to the right partners, and have an innovative upcoming generation. To compete, continuous innovation and global collaboration will be key (Participant #2). One opportunity window is, to seek large and innovative IT partners, for the implementation of upcoming technological trends. For instance, generative AI, robots, etc. the fourth industrial revolution will change, the way customers use cars. A strong collaboration with neighbouring industries, that are using and implementing these megatrends, is beneficial (Participant #9). Additionally, could German automotive firms use their regulative government in terms of sustainability and evolve a brand image around greener cars. Currently, German cars are more known for their engineering, but the following regulations throughout the supply chain can become their unique selling point. In comparison to China, the U.S., and Japan, this would be a competitive advantage and might even shift the target customer towards a younger, but long-lasting generation (Participant #3). Here, digital transformation and open innovation can be used as enablers (Participant #5).

#### 4.2.4. Threats

For the German automotive industry, one of their opportunities is simultaneously one of their threats. Sustainability is a challenge because it requires large investments and is often slowing down performance, due to technological sacrifices (Participant #9). Besides the above mentioned, the megatrends are all relevant in the future and can be threatening, if not implemented correctly. The literature review and exploratory interviews do agree, that China is one of the biggest threats for German automotive firms and with coming market saturation. Because China has fewer regulations and can act more aggressively and faster, building and

elaborating on their existing knowledge (Participant #8). VW used to be the most-sold car in China, but last year it was replaced by BYD. In Germany every third car is exported to China, if Chinese firms can serve their home market customer demands better than Germany, this will result in a serious threat. German automotive firms need to innovate or acquire new markets heavily (Participant #4).

### **4.3. Future outlook**

In general terms, the German automotive industry should focus on heavily implementing and using open innovation and digitization, to keep up with competition. However, in the long run, with a rising population and new generations that act more environmentally cautious, the focus will shift more towards sustainability. This is a global challenge, that everyone in the automotive industry will experience (Participant #5). Additionally, will the rise of these megatrends shape consumer behaviour, in 2025, up to 36% of citizens in urban areas are said to use sharing economy services. This could lower vehicle car sales by 24% (Deloitte, 2017). Germany should try to not be as perfectionist about the new implementation and follow a riskier approach. China has already a just-do-it mentality with fewer regulations, and the U.S. has very diverse firms. Some are old and traditional, which are lacking in innovation and environmental practices but satisfy a large customer base, and others are digital natives and technological pioneers. Japan hits the boxes partly on all megatrends, but not to a tremendous greater extent. But are known for being very cost-effective and reliable (Participant #3).

## 5. CONCLUSION

### 5.1. Answering the Problem Statement

This Thesis was based and built on the question:

*Will the German automotive industry be able to compete, survive, and reproduce under the megatrends of sustainability, digital transformation, and open innovation?*

The previous analyses dealt with answering the research questions, which jointly respond to the problem statement. The findings have shown, that all three megatrends are essential to thrive in modern times. Digital transformation is seen as the one that should be prioritized by German automotive firms when making strategic decisions, but also as the one that is the toughest to implement and demands detailed change management. Both digital transformation and open innovation act as enablers for other megatrends, while sustainability does foster idea creation but does not facilitate other megatrends. All relationships between megatrends are seen as positive and empowering, except the one between digital transformation and sustainability does emphasize positive and negative aspects, but the majority is beneficial.

Sustainability findings show that it acts as an important strategic part, especially in the future with a rising population and even more environmental disasters, but since the direct positive effect is not seen by either firms or customers it is often not prioritized. Even further, is it costly with often no direct financial return, and might even set technological or performance limits. Therefore, most German automotive firms fulfil the given regulation by the government but tend not to invest heavily in sustainable solutions.

Open innovation was almost solely perceived as beneficial within the findings, it is praised as being extremely valuable but in comparison to digitalization, it is not the priority in strategic decision-making. The analysis shows, that open innovation is often used by German automotive firms to acquire capabilities and knowledge, especially in the technology sector, when firms are missing it themselves and it takes too long to develop them on their own. Open innovation is seen as having a positive and enabling influence on other megatrends, and only the operational practices while implementing could be challenging.

Digital transformation was ranked as the backbone and number one priority that German automotive firms should focus on. In comparison to competition from China, Japan, and the U.S., German automotive firms have opportunities to gain competitive advantage through the interplay and implications of megatrends. Nevertheless, traditional German automotive firms should participate in a riskier approach when making decisions and not rely on their reputation of being engineering experts. With the continuous rise of the Industrial Revolution 4.0, customer demands will shift towards new driving behaviours. They need to bear in mind the intercorrelations of the megatrends to experience the full potential and implement such in the entire ecosystem.

## **5.2. Limitations**

The chosen methodological approach for this research paper facilitates the basis for relevant insights to answer the stated research questions, nevertheless, it is important to highlight several limitations:

This paper offers a comprehensive review of 35 articles in addition to books, company reports and statistical data, studying the influence of the three megatrends of digital transformation, sustainability, and open innovation on the German automotive industry. Additionally, expert interviews were conducted to support or refute existing findings from the literature review. Despite the efforts to mitigate bias through careful inclusion and exclusion criteria, it is relevant to mention that the information and answers from the interviews have been chosen based on subjective judgments, introducing a potential source of bias. Therefore, the thesis may not offer an all-encompassing overview and could lack crucial information regarding the influence of the megatrends on the German automotive industry. However, within the given scope of the academic dissertations, its length and resource capabilities, diversity in sources was granted, leading to a bigger picture to answer the research question.

Further, this research is conducting the influence of the megatrends on the German automotive industry and analyses the future outlook compared to competition from China, the U.S., and Japan. One needs to bear in mind, that competition can as well arise through new entrants in the market. For example, is Lilium a German-based company that is building autonomous air taxis which could transform the competitive landscape in the future. As well as automotive firms, they specialize in urban mobility, introducing high-speed regional air mobility in electric autonomous mini jets (Lilium, 2023). The scope of this research focuses on a restricted area,

and therefore it limits the generality of results. This is a contextual constraint of going deeper into the analysis of competitors and the market as a whole.

The final result of the interview questions is always influenced by the characteristics of the interviewer (Bell et al., 2019), and therefore the outcome and the interpretation as well partly subjective. This holds as well true for the chosen sample size, even though it was chosen due to diversity, limitations still hold. More experts could have been interviewed, and people from competing countries would have a valuable insight. Hence, this paper experiences a researcher bias, especially due to professional knowledge and experience in the automotive industry. The primary data collection was also restricted through anonymity in a professional environment and due to company confidentiality. The name-dropping or more detailed description in interviews could have potentially enabled a more in-depth analysis.

For the analysis of the primary data collection, coding was used to process the data and analyse the fit or support towards the research questions. Coding is sometimes criticized for fragmenting and decontextualizing the data (Bell et al., 2019). Lastly, the research was conducted to the researcher's best knowledge, but human work tends to be never fully error free and therefore this paper offers the above-mentioned limitations and will provide recommendations in the following section.

### **5.3. Future recommendations**

This research paper serves as a valuable base for future research evaluating the impact of megatrends on the German automotive industry. The answer to this research question and the following recommendations can serve as a base for conducting in-depth studies in the future.

#### *Methodological recommendation*

First and foremost, a quantitative analysis could be the next step to further support the findings of this paper. One could either gain statistical data about how German automotive firms are investing in certain megatrends and their given outcome on performance, or one could survey professionals to collect data or a larger, more representative sample size.

Regarding the sample size, it would be valuable to interview professionals from competing countries and additionally, as well the view of customers, to gain a holistic picture of the prominence of these trends.

Lastly, to improve methodology, an extension of research will be valuable. The German automotive market is ever-evolving, therefore longitudinal cross-case studies could pinpoint future outcomes in more detail since they explore and capture change and adaptation over time.

Suggestion of potential avenues for future research by addressing the identified gaps in the existing paper:

*Include new entrants to the market*

To conduct an in-depth analysis, a larger market should be incorporated. The literature review could not only focus on traditional car brands but also consider the threat of new entrants within the market. The interconnectivity and globalization of the twenty-first century, as well as economic and technological disruptions, have reshaped the market in many industries and are forcing firms and markets to restructure (Marković & Mijušković, 2022). Here, new entrants enter markets to disrupt and gain a competitive advantage through the emerging change.

*Include neighbouring industries*

Future studies should examine the conjunction of the megatrends with related industries. Especially for the automotive sector, the supply chain touches many other industries such as manufacturing, electronics & technology, energy & fuel, insurance, logistics & transportation, finance, etc. Here, the impact of the megatrends could offer meaningful insights into the present and future outlook.

If the above-mentioned recommendations are taken to heart in follow-up studies, I believe that the new approach could be fruitful in examining the influence of the three megatrends on the German automotive industry.

#### **5.4. Managerial relevance**

As the analysed megatrends are very relevant and evolving in their nature, companies feel external and internal pressure to rethink their strategies. The theories and assumptions created in this thesis lay a foundation for real-life business situations and decision-making. It will help managers to make informed decisions and reduce their risks by knowledge extension. The in-depth evaluation of the German automotive industry does as well raise awareness of important and urgent topics for firms within the industry new entrants and neighbouring industries.

Through the assessment of the megatrends and their interplay, practical implications are highlighted, as the importance of adjusting to these to compete successfully, as well across borders of countries. The laws and regulations are different in locations, but often, automotive firms compete on a global scale. Therefore, firms need to adjust, select the market that suits them well, and start adapting megatrends in their strategies to increase performance. Even though a lot of positive impacts do result from megatrends, managers should enjoy the opportunities with caution. Their implementation and usage offer the potential for conflict, and resistance, and need careful upskilling and road mapping before implementing.

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## 7. APPENDIX

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## 7.1. Semi-structured interview-guide

Define objective and scope:

The semi-structured interview aims to gain further insights into the dynamic landscape of the German automotive industry under the influence of the megatrends' sustainability, open innovation, and digital transformation. By conducting expert interviews with people working in the German automotive industry, the aim is to shape a clear picture of the current status concerning these megatrends and their future outlook. In the long run, the problem statement is to answer, how these megatrends will shape the industry and influence the competitive position of German automotive firms, especially against China, the U.S., or Japan.

### Participant:

Name:

Age:

Gender:

Job Title/automotive relation:

### Introduction:

Could you please introduce yourself and your connection to the German automotive industry?

### SUSTAINABILITY:

1. Do you value sustainability as an important strategic topic for firms in the German automotive industry? Rate from 1 to 10 (1 being the lowest evaluation and 10 the highest one)
2. Has your company integrated sustainability practices into its operations/Have you integrated sustainability in work projects? If yes, can you provide examples?
3. In what ways do sustainability considerations influence the decision-making process in your organization/in your projects?
4. Are there challenges, when implementing sustainable practices?
5. Do you think the German automotive industry acts sustainably?
6. How do you view the Germans automotive standing in terms of sustainable practices, in comparison to its competition in China & U.S.?

### OPEN INNOVATION:

7. Do you value open innovation as an important topic for firms in the German automotive industry? Rate from 1 to 10 (1 being the lowest evaluation and 10 the highest one)
8. Does your company approach open innovation/do you experience open innovation in your projects? If yes, how?
9. Do you feel like your company is benefitting/is challenged from/by open innovation?
10. Do you observe open innovation in the German car industry?
11. How do you view the German automotive standing in terms of open innovation, in comparison to its competition in China & U.S.?

#### DIGITAL TRANSFORMATION:

12. Do you value the topic of digital transformation as an important topic for firms in the German automotive industry? Rate from 1 to 10 (1 being the lowest evaluation and 10 the highest one)
13. To what extent has your company/your projects embraced digital transformation?
14. What challenges or opportunities have arisen through the process of digital transformation in your individual experience?
15. How do you see the role of new emerging technologies (AI, IoT, data analytics) evolving in the future of the German automotive industry?
16. How do you view the German automotive standing in terms of digital transformation, in comparison to its competition in China & U.S.?

#### INTERPLAY BETWEEN MEGATRENDS:

17. How do you think sustainability and open innovation interplay?
18. How do you think sustainability and digitization interplay?
19. How do you think digitization and open innovation interplay?
20. Can you provide examples of innovative solutions that emerged from the synergies between these megatrends?

#### MEGATRENDS INFLUENCE ON THE GERMAN AUTOMOTIVE INDUSTRY:

21. How do you view the convergence of sustainability, open innovation, and digital transformation for the German automotive industry?
22. Which megatrend do you feel will/has the most positive influence strategically on the German automotive industry? Please explain why?

23. Which megatrend do you feel will/has the most negative influence strategically on the German automotive industry? Please explain why?
24. How do you view the competitiveness of the German car industry long regarding the megatrends?

OTHER/ENDING:

25. Is there anything else you like to discuss/add?

Thank you for your participation and time! For any further recommendations, I am reachable at my mail address: [lilly@dclanio.de](mailto:lilly@dclanio.de)

## 7.2. Participants

<i>Participant</i>	<i>Age</i>	<i>Gender</i>	<i>Country</i>	<i>Job Title</i>	<i>Interviewed</i>
#1	79	Male	Germany	Car enthusiast and former CEO of an advertising Company in Hamburg, Germany with car companies as clients	30.11.2023
#2	25	Male	Germany, Austria	Intern at Horvath & Partners (Consulting) with automotive focus and car enthusiast	02.12.2023
#3	55	Male	Germany	CEO of Syzergy, Performance Marketing in Hamburg, Germany with car clients	30.11.2023
#4	28	Male	Germany, Austria	Senior Consultant at Capgemini Invent in the automotive sector	05.12.2023
#5	30	Male	Germany	Senior Consultant at Capgemini Invent in the automotive sector and former senior consultant at MHP (Porsche) for 2 years.	01.12.2023
#6	25	Female	Germany	Former Intern at BMW Startup Garage, studies at TUM Munich, Germany and has experienced cooperation's with car companies from the University	05.11.2023
#7	26	Female	Germany	Senior Consultant Capgemini Invent in the sales sector for automotive firms	07.12.2023
#8	51	Male	Portugal	Assistant Professor at Católica Lisbon School of Business & Economics, Scientific Areas: Operations and Data Science	07.12.2023
#9	24	Female	Germany	Former Intern at Porsche Consulting, BMW Group, Accenture & MHP	07.12.2023

### 7.3. Interview Coding Example

Below is an example of one transcript interview from Participant #5, here the answers were scanned and highlighted according to the color code of Excel. The highlighted text represents useful answers which are then transferred to the Excel for further slimming of the answers and to choose useful arguments for the discussion part.

#### SEMI-STRUCTURED INTERVIEW #5

Define objective and scope:

The semi-structured interview aims to gain further insights into the dynamic landscape of the German automotive industry under the influence of the megatrends' sustainability, open innovation, and digital transformation. By conducting expert interviews with people working in the German automotive industry, the aim is to shape a clear picture of the current status concerning these megatrends and their future outlook. In the long run, the main problem statement is to answer, how these megatrends will shape the industry and influence its competitive position, especially against China, the U.S., or Japan.

#### Participant:

Name: -

Age: 30

Gender: male

Job Title/automotive relation: Senior Consultant at Capgemini Invent, Focus topic automotive, former consultant at MHP Porsche

#### SUSTAINABILITY:

1. Do you value sustainability as an important topic for firms in the automotive industry? Rate from 1 to 10 (1 being the lowest evaluation and 10 the highest one)  
*9*
2. Has your company integrated sustainability practices into its operations? If yes, can you provide examples?  
*We see a rise in projects with a focus on sustainability evaluation within supply chains, however the focus does not lie on sustainability within projects, they just come along with projects.*
3. In what ways do sustainability considerations influence the decision-making process in your organization?  
*We always evaluate on what certain consultants should specialize on in order to serve future projects with valuable knowledge. Sustainability has become a rising topic here; we have educated several specialists within Capgemini Invent.*
4. Are there challenges, when implementing sustainable practices?

*Well, you know, it is tough for companies to really grab attention in the crowd of competitors. At the same time, if we don't jump on the sustainability bandwagon, firms risk getting some pretty bad press. It is like we are caught between a rock and a hard place, trying to find a sweet spot.*

5. Do you think the German automotive industry acts sustainably?  
*I would say they are making strides; you know? There is definitely a push for sustainability, but it is a work in progress. Some companies are doing better than others, and there is room for improvement across the board. I would say they are on the right path, but there is still a very very long road ahead.*
6. Do you think, that competition from China, the US, or Japan is more sustainable than German car brands?  
*Yeah, I'd say Germany is really making an effort to go green, more so than the competition, especially from outside of Europe. They seem committed to the whole eco-friendly vibe throughout their entire process.*

#### OPEN INNOVATION:

7. Do you value open innovation as an important topic for firms in the German automotive industry? Rate from 1 to 10 (1 being the lowest evaluation and 10 the highest one)  
*10*
8. Does your company approach open innovation? If yes, how?  
*Yes, we have partnerships with some corporations, mostly for the reasons of knowledge sharing and educating our consultants.*
9. Do you feel like your company is benefitting from open innovation?  
*/*
10. Do you observe open innovation in the German car industry?  
*I think Germans often are scared of resource or capability sharing. But more and more topics, which are not their core competency began to become more important. Here, German automotive firms need to start seeking for partnerships, joint ventures, etc. Especially with other industries that might be a few steps ahead they could benefit.*  
  
*On the other side, are German car companies using open innovation in their own supply chains. They involve their suppliers heavily in certain processes. As well have BMW, Ford, Hyundai, Mercedes-Benz, VW, Audi and Porsche created the joint venture Ionity. They are building a European network for electric charging station and want jointly face their biggest competition in this field, Tesla.*
10. Do you think that competition from China, the US, or Japan is using open innovation more frequently than German car manufacturers?  
*As mentioned before, German car brands are too scared to engage fully in knowledge sharing, the USA has a different mindset on knowledge sharing, they use it heavily and China is rather inward focused.*

#### DIGITAL TRANSFORMATION:

12. Do you value the topic of digital transformation as an important topic for firms in the German automotive industry? Rate from 1 to 10 (1 being the lowest evaluation and 10 the highest one)

9

13. To what extent has your company embraced digital transformation?

/

14. What challenges or opportunities have arisen through the process of digital transformation in your individual experience?

*Always an increase in efficiency, a lot of firms only transform partly and missing out on important interfaces within the company. That's why a whole digital transformation, mostly always wins in the long run, even though initial costs are enormous. For example, Spotify has transformed the business model of CDs to 100% digital, transforming the whole market.*

15. How do you see the role of new emerging technologies (AI, IoT, data analytics) evolving in the future of the German automotive industry?

*I think digital transformation is the most important one that German automotive firms should focus on since it is the basic building block for other megatrends.*

*This was, for example, one of the reasons why BMW Startup Garage was created, to find solutions for old internal processes. Even the tech. office in Munich was very old school and not very advanced in terms of digital technologies.*

16. How do you think competition from China, the US, or Japan handles the topic around digital transformation?

*Tesla pioneers in innovations towards autonomous driving and China programs its cars in such a way that entertainment and comfort is first priority.*

*I think we are not better worse of then competition. The USA for example with GM or Ford is lacking behind in being innovative. China is very digitized in their internal processes, etc. but rather stronger in their own home markets.*

#### INTERPLAY BETWEEN MEGATRENDS:

17. How do you think do sustainability and open innovation interplay?

*Open innovation has an enormous influence on sustainability, I would even call it an enabler for sustainability.*

18. How do you think do sustainability and digitization influence each other?

*Digitization has an influence on sustainability in terms that is enhances predicative maintenance through for example digital twins, and detect mistakes before they even occur.*

19. How do you think do digitization and open innovation impact each other?

*I think they both influence each other positively.*

20. Can you provide examples of innovative solutions that emerged from the synergies of these megatrends?

*Open innovation has a positive influence on sustainability and digital transformation, it can be seen as a driver of both!*

#### MEGATRENDS INFLUENCE ON THE GERMAN AUTOMOTIVE INDUSTRY:

21. How do you view the convergence of sustainability, open innovation, and digital transformation for the German automotive industry?

*I think digitalization and sustainability are both equally important and demanded and can both be enhanced by open innovation. Especially innovative Startups could provide with great ideas to combine both.*

22. Which megatrend do you feel will/has the most positive influence on the German automotive industry?

a. Please explain why?

*Looking ahead, I think the next two decades will be all about digital transformation. But the grand scheme, especially with growing populations in places like China, the USA, and Japan, there's shift towards putting more emphasis on sustainability and figuring out how to deal with it. It is like a long-term sustainability game plan, that is needed.*

23. Which megatrend do you feel will/has the most negative influence on the German automotive industry?

a. Please explain why?

*Open Innovation*

24. How do you view the competitiveness of the German car industry long-term regarding the megatrends?

*It is more than ever important that German car brands are waking up and seeing the need in incorporating these megatrends within their business models. They are, to a certain degree, already behind competition and need to wake up in order to compete. Cybersecurity is an area where we could outperform the competition.*

#### OTHER/ENDING:

25. Is there anything else you like to discuss/add?

*China might produce more electric vehicles but is not as sustainable in their supply chains as Germany. The German environmental regulations and laws are already very strict in producing green. Germany could gain a competitive advantage if they focus on green supply chains and use them as their brand image. Here, they could use open innovation for innovative ideas within supply chains, such as a replacement for rubber tires, etc.*

Thank you for your participation and time! For any further recommendations, I am reachable at my mail address: [lilly@dclanio.de](mailto:lilly@dclanio.de)

## 7.4. Interview Coding Excel

The above screenshot shows the advanced coding of the exploratory interviews. The color blocks on the top represent the clustering themes (Green: sustainability, Blue: Open Innovation, Orange: Digital Transformation, Yellow: the interplay of megatrends, and pink: future outlook). On the left side, all participants are displayed and the body of the table contains important and relevant answers. The blue highlighted text was lastly chosen as a representative argument for the analyses and can be found in the discussion part.

The upward screenshot is a zoom-in of the first screenshot to shape a clearer picture of the coding process. For further questions or access, please ask the researcher (Lilly Lanio, [lilly@dclanio.de](mailto:lilly@dclanio.de)).

## 7.5. Table of definitions

Table 4: Definition

<b>Term</b>	<b>Definition</b>	<b>Source</b>
Digitization	Radical rethinking of how an organization uses technology, people, and processes to fundamentally change business performance	Westermann et al., 2014
Digital Twin	Virtual replicas of the cars, which can be used for simulation and analysis	Writer, 2023
Sustainability	Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs	Brundtland Report, United Nations, 1987
Open Innovation	The use of purposive inflows and outflows of knowledge to accelerate internal innovation, and to expand the markets for external use of innovation, respectively	Chesbrough et al., 2006
B-corporations	Corporations with the mission to cause no unnecessary harm and implement solutions to sustainability issues in their business model	Bcorporation, 2023
Original Equipment Manufacturer (OEM)	An OEM is the original producer of a vehicle's components, these being identical to the parts used in producing the vehicle, making them an original supplier	Khartit, 2021
Sustainability-oriented innovation (SOI)	Realized ideas that improve environmental and/or social performance compared with the current situation".	Kennedy, Whitemann & van den Ende, 2017