In what ways does AI support the integration of ESG projects in leading companies within the automotive industry like Tesla, Ford, Audi, BMW, Porsche, and Mercedes?

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ABSTRACT,
The purpose that this bachelor thesis serves is to shed light on the artificial intelligence-sustainability projects of companies like Tesla, Ford, Audi, BMW, Porsche, and Mercedes. This research first introduces the reader to relevant concepts such as Corporate Social Responsibility, Artificial intelligence, ESG projects and sustainability, as well as provides a comparison of the views on CSR of two of the most influential people on the topic- Carroll and Bhatacharya.
As artificial intelligence is headly beginning its journey as a technological breakthrough without a substitution, sustainability does not give up to it. With its help, car companies are trying to be more sustainable, while simultaneously digitalizing the majority of their company operations. These operations (or activities) are analyzed in a more detailed manner in the second part of this report, where a summary of their AI-Sustainability projects is presented. What this study shows is that all of the analyzed companies are focusing their projects on reduction of CO2 emissions as well as diminishing of supply chain sustainability risks, and the approaches they take towards these goals are somewhat similar.

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Artificial intelligence, automotive industry, ESG projects, sustainability, machine learning, algorithms, society, environment.

1. INTRODUCTION

Artificial intelligence is a term, starting to appear everywhere more and more frequently nowadays. We can read about it in the press-releases, hear it being mentioned on the TV and internet, as well as being part of the resolutions of some of the biggest companies in the world, and not only.

So, what is artificial intelligence? According to the Father of Artificial intelligence, John McCarthy, "It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable" (McCarthy, 2012).

Having its positive, as well as negative sides, artificial intelligence can be a powerful addition to any company, by increasing its social value. One of the benefits it offers is carrying out tasks much faster, and with less mistakes than humans, leading to increased effectiveness. Furthermore, the greater efficiency of the company can be reached by AI's ability to analyze data in no time, leading to intensified and advanced decision-making (Leszkiewicz et al., 2021). On the contrary, to execute given tasks could turn out to be too costly for most of the companies, as well as sometimes hard to implement, as the processes within the organization should be adjusted around the new technology, with the possibility of lack of skilled people doing it (Leszkiewicz et al., 2021).

The automotive industry is one of the fields in which artificial intelligence steps in and experiences rapid growth. Some of the existing developments include, but are not limited to "impact detection, self-driving programs, and built-in smart assistants" (Williams, 2017). These advancements are not only serving in a substantial way the society in terms of convenience, but they are also impacting the environment by bringing down the number of cars driving on the streets, which leads to reducing the total of accidents happening on the roads, less traffic, and less need of emergency vehicles (Williams, 2017).

What is more, any company, regardless of size or type of expertise it offers, can develop different business models and projects with the help of artificial intelligence, which can then be optimized in such ways, that they would ensure and support the sustainable future of the company that everyone strives for (di Vaio et al., 2020). They are the so-called ESG projects (environmental, social, governance), which would be looked at more in-depth further in the report.

Therefore, the goal of this bachelor thesis is to investigate how can artificial intelligence in the automotive industry help and guide companies towards their way of being more sustainable and environmentally friendly, with the help and implementation of their ESG projects.

2. RESEARCH OBJECTIVE

Artificial intelligence in the field of automobiles manufacturing has until now mainly been researched in terms of autonomous self-driving vehicles, which have been included in the assortment of the leading car companies (Lutkevich, 2019). However, the focus of this research is to observe in what ways do these car companies try to become more sustainable with the help of artificial intelligence.

The technological breakthroughs happening in the past years are making the lives of people less complicated, and this topic is relevant especially in terms of the automotive industry. Various inventions have been introduced- from apps, saving journey time, to smart streets, scanning and showing available parking spots (Williams, 2017). Due to all the advancements achieved in machine learning, artificial intelligence has become one of the main actors taking part in the car manufacturing processes nowadays (Williams, 2017).

Self-driven cars have begun to become more popular recently, and they can be noticed across the biggest cities in the world, since these are the places that they are being tested in a real-life environment (Cugurullo et al., 2020).

As artificial intelligence has become more popular and easily accessible in terms of information provided to the public recently, automobile manufacturers started considering incorporating it into their future projects with one main vision- increased safety of their products (Gonzalez, 2022).

What is more, the ability to have a personalized vehicle, as a form of expressing yourself as an individual, based on your personal preferences, strikes as being appealing to both manufacturers and customers, and it leads to increased interest towards incorporating artificial intelligence faster (Gonzalez, 2022).

Finally, in-car assistance, as opposed to being something extraordinary years ago, has started to become the norm these days with the help of artificial intelligence algorithms. In just two years, from 2018 to 2020, the percentage of cars with built-in car-assistance technology, has grown from 30% to 45%, with Mercedes being the leader in the field (Gonzalez, 2022).

The expansion of the automotive industry is evolving daily. As a "consequence" of people's desire to be more eco-friendly and cut bad emissions, electric vehicles have started to take precedence over conventional ones (*Western Asset Insights: An ESG Perspective on the Automotive Industry*, 2020). Automotive companies have started to invest in the so-called ESG projects, related to sustainability, as they feel the pressure to speak up to the safety of the vehicles they produce, as well as how the production process impacts both the environment and the society (*Western Asset Insights: An ESG Perspective on the Automotive Industry*, 2020.

The aim of this research is to discern the ways and approaches that organizations in the car industry undertake when doing their best to incorporate these ESG projects, utilizing artificial intelligence.

The biggest companies in the automotive manufacturing industry, such as Tesla, Ford, Audi, Porsche, and Mercedes have all already made use of artificial intelligence, and apart from that, have taken part in multiple sustainability initiatives, trying to be more ecologically friendly. However, the research on both perspectives combined has been limited, leading to insufficient materials about the topic yet. This bachelor thesis's aim is to shed light on the subject and answer the following research question:

In what ways does AI support the integration of ESG projects in leading companies within the automotive industry like Tesla, Ford, Audi, Porsche, and Mercedes?

3. THEORETICAL FRAMEWORK

3.1 Artificial intelligence

Machine learning and AI are beginning to turn into one of the most important instruments for approaching and tackling different problems in omnifarious areas (Kersting, 2018). Artificial intelligence has been divided into two parts- weak AI and strong AI, and what differentiates the one from the other is the approach that it takes towards solving a problem. Weak AI, also known as Narrow AI, has been designed in a way that its abilities lie in the area being trained to only execute specified assignments (Education, 2021). On the contrary, Strong AI consists of two parts- Artificial general intelligence (AGI) and Artificial super intelligence (ASI). AGI, being the theoretical configuration of AI, with intelligence equal to that of humans,

has the potential to work out problems and draw up the future. Furthermore, superintelligence, even though still only theoretically, excels the abilities of AGI, by being more intelligent than a human's brain itself (Education, 2021).

Nowadays, artificial intelligence has been accredited as a game changer in the world of the automobiles, even though there are many challenges and obstacles leading in the other direction for now (jordan.friedman, 2022). Since artificial intelligence has the possibility to predict what is going to happen and then act upon it, the automotive industry could utilize it in such ways that it enhances cars' performance, as well as environmental and societal impact.

Five ways, in which machine learning could be taken advantage of, include: invention and manufacturing of partially or fully autonomous vehicles, manufacturing of electric and low-emission cars, virtually designing and testing different prototypes, without the risk of losing money in case of a failure, making use of manufacturing equipment in an alternative way, and effective quality control (Hastings, 2022).

3.2 Sustainability

Sustainability has recently started to gain more popularity and take the shape of one of the main goals and long-term visions of companies. It is something that most businesses strive for and try to incorporate into their everyday operations, and the basic and most simple explanation of the term is that sustainability represents "using resources to meet the needs of the present without compromizing the ability of future generations to meet their own needs" (Ahi & Searcy, 2015). This concept first appeared in 17th/18th century, but it has been absorbed into the mainstream in the 1980s by being popularized by the Brundtland commission (Purvis et al., 2018).

When describing sustainability, the three "pillars" must be mentioned. Usually, they are presented as a Venn diagram- three overlapping circles, with sustainability in the middle. However, the idea could be also illustrated with the help of concentric circles, although it is not done very commonly. The fact that the three aspects are called pillars, leads to the third graphical representation of the concept- three factual pillars, individually representing the three separate concepts of sustainability- social, environmental, and economic (Purvis et al., 2018). The three types of illustrating sustainability could be seen in Figure 1.

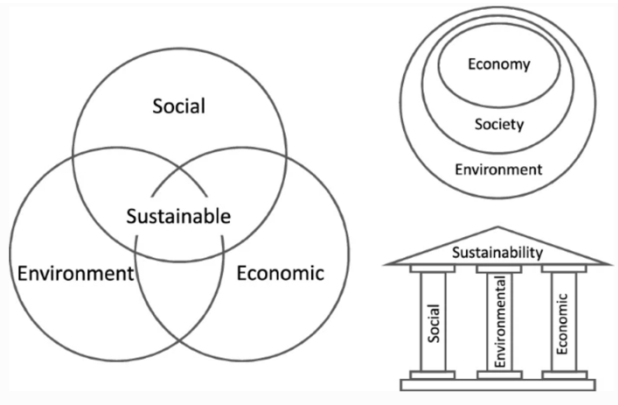

Figure 1. Graphical representation of sustainability (Purvis et al., 2018)

Sustainability can be divided in two- weak sustainability, and strong sustainability (Kuhlman & Farrington, 2010). According to Barbier (2013), they can be described respectively as:

(i) "That the next generation should inherit a stock of wealth, comprising man-made assets and environmental assets, no less than the stock inherited by the previous generation;

(ii) That the next generation should inherit a stock of environmental assets no less than the stock inherited by the previous generation".

3.3 Triple Bottom Line

This ongoing research is aimed to not only help companies, but also help society. The triple bottom line, also known as the three P's (people, planet, profit) (Henriques & Richardson, 2013), is a sustainability concept which helps in understanding and illustrating how this happens. It has been first introduced as a sustainability concept in 1987 by the United Nations World Commission on Environment (Braccini & Margherita, 2018). It comprises of three aspects- environmental value form, social value form, and economic value form, and they all combine into the sustainable value, as it can be seen in Figure 2.

Figure 2. Triple Bottom Line (Taylor, 2020)

The environmental dimension, which corresponds with the planet aspect of the three P's, focuses on the usage and renewal of resources in nature (Correia, 2019). It is closely related to the companies' aspirations to reduce their footprints and negative impacts on the surroundings, and it is arguably the most important one out of the three (Correia, 2019).

Moreover, the social dimension refers to the happiness and well-being of the customers and employees, and the society as whole. It concerns issues like "education assistance, community interaction, charitable causes, and fair fare practices" (Correia, 2019).

Finally, the economic dimension's focus lies on, but it is not limited to profit. It is closely related to what the companies can give as a value to the customers, and it goes further than the financial performance of the company in terms of sales, cash-flow, and value for the stakeholders (Correia, 2019).

Dahl (2012) argues that additional dimensions to the triple bottom line should exist, such as institutional, cultural, or ethical, and that would encompass "governance, efficiency, motivation, values, and other less tangible factors that may be important determinants of sustainable human prosperity (Dahl, 2012).

3.4 CSR and Stakeholders' Wellbeing

3.4.1 Carroll Four-Part Model of CSR

Corporate Social Responsibility is a valuable complementation to the Triple bottom line in terms of economic, social, and environmental performance of a company (Macassa et al., 2020). It represents a concept that speaks for the importance of the responsibility of corporations towards their stakeholders, the community, and the surroundings (Blowfield, 2005).

One of the most popular and widely cited articles in the business and society circles, many years after being published, is Carroll's four-part model of CSR (Lee, 2008). The author has developed a graphical representation of Corporate Social Responsibility in the form of a pyramid. Consisting of four layers, the pyramid, which can be seen in Figure 3, comprises the four responsibilities of companies, that are expected from society- economic, legal, ethical, and philanthropic.

Figure 3. Carroll's Pyramid of CSR (Carroll's Pyramid of CSR, n.d.)

As a main prerequisite for existence, companies must have economic responsibilities to the society, with the help of which they sustain themselves in the working environment. This is something expected and even required by the society nowadays, and it is imagined that the only way in which it can be achieved is by being cost-effective and profitable (Carroll, 2016).

When taking in mind corporation's social responsibilities, it is always thought of working towards financial effectiveness in the face of investments, cost-reduction, emphasis on revenues, etc. Even though the economic responsibility is the baseline which companies must meet to be in a competitive position, there are other aspects to take in mind as well (Carroll, 2016).

Society has also put in place a set of rules under which companies are expected to intervene. They serve as a condition of executing business operations and include rules, laws, and regulations such as "complying with various federal, state, and local regulations", "performing in a manner consistent with expectations of government and law", etc. (Carroll, 2016).

Along with complying to rules and norms, the community expects corporations to execute their everyday operations in an ethically appropriate manner. Although it is not actually requested by law, businesses are expected to act in accordance with the ethical norms posed by the society. Ethical expectations are responsible with the activities which do not fall under the scope of the law and regulations but are rather either forbidden or anticipated by society (Carroll, 2016). They may include "being good corporate citizens by doing what is expected morally or ethically", recognizing and respecting new or evolving ethical/moral norms adopted by society", and so forth (Carroll, 2016).

Finally, philanthropic responsibility includes all sorts of corporate giving. It is not completely obligatory for companies to practice it; however, it is still to an extent expected by the population. To fulfil their philanthropic responsibilities, companies take part in various giving acts- "gifts of monetary resources, product and service donations, volunteerism by employees and management, community development", etc. (Carroll, 2016).

3.4.2 Stakeholders' Health and Wellbeing

Stakeholder theory puts forward the idea that every enterprise is a social unit with responsibilities not only to shareholders, but also to other groups of interest (Stojanovic-Aleksic & Boskovic, 2017).

The stakeholder concept is a relatively new way of trying to understand how organizations function. In 1963, the Stanford Research Institute introduced the term shareholders, as the only group of people needed to be considered when managing a company (Jongbloed et al., 2008). However, Freeman (1984) asserted that other stakeholders' points of view should also be appraised (Wagner Mainardes et al., 2011). According to him, "there are other parties involved including customers, employees, suppliers, governments, competitors, consumer advocates, environmentalists, special interest groups and the media". Moreover, according to Gibson (2000), businesses have also a moral responsibility to the stakeholders (Stojanovic-Aleksic & Boskovic, 2017).

Even though focus has been put on stakeholders throughout the past decades, it has always been little and not enough. Nowadays, businesses are broadening the emphasis they are putting on their stakeholders in various ways. They are extending the scope of the focus they put on them, as well as supporting the development of their deeper engagement and well-being. Companies have started to mark well-being as a priority, as well as started to realize the role they play themselves in shaping the behavior and attitude of all the stakeholders (Kumar & Ramachandran, 2021).

Linking Corporate Social Responsibility to stakeholders' well-being, it has been observed that it has many practical implications in the long run. CSR involves having social responsibility towards different internal and external stakeholders- the external ones being related to the society, and the internal ones- to the company itself (Macassa et al., 2017). The benefits that a company presents to its stakeholders through CSR include "strengthening the brand, improving the image" (Virvilaite & Daubaraite, 2011), as well as "the ability to attract, motivate and retain employees and consumers" (Kotler & Lee, 2004). What is more, it is now expected by employees that the companies are actually demonstrating their social responsibility by granting them with rewards, personal development trainings, involvement in the organization, retirement benefits, etc. (Tamm et al., 2010; Zanko & Dawson, 2011).

In the long run, the combination of these factors leads to reduction of costs and improved position in the competitive environment (Porter & Kramer, 2006).

3.5 CB Bhattacharya Point of View (Doing well by doing good)

According to Bhattacharya (2016), the different approaches towards sustainability can be mapped out on a four-dimensional matrix, the quadrants of which are being categorized by the business value and socio-environmental value of a company. (Figure 4.)

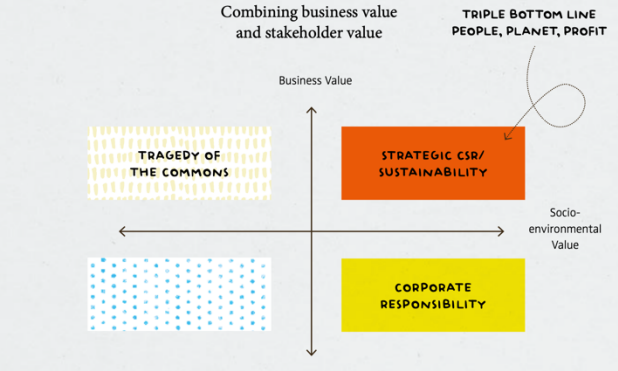

Figure 4. Combining Business Value and Stakeholder Value (Bhattacharya, 2016)

When examining the matrix, it can be observed that the companies that have high business value but low socio-environmental one, fall into a situation called "tragedy of the commons". It refers to a case where an individual has a stimulus to utilize a resource, by not being restrained by social structures or rules, and he does that at the expense of all other individuals (V. Purvis, 1970). However, corporations can no longer allow themselves to be positioned in the top left quadrant, as they would need to maximize the positive socio-environmental value their company poses to the world. It is considered a must, if companies wish to keep their operating licenses (Bhattacharya, 2016).

If an organization finds itself in the right-hand side of the matrix, in the bottom-right quadrant- corporate responsibility, it means that they did not manage to integrate their sustainability efforts and achievements into their business strategy- their business value is low (Bhattacharya, 2016). In other words, they are spending a lot of money on integrating various sustainability projects, which, however, do not generate any profit for them, leading to the fact that these sustainability initiatives are intrinsically seen to be competing with the company's business objectives (Bhattacharya, 2016).

According to the author, high business value (bigger profits), in combination with high socio-environmental value (caring for the planet and its inhabitants), is the quadrant that each organization should strive to fall into. This field could also be referred to as the triple bottom line, and a company focusing on it acquires more sustainability initiatives and cares for its employees' and customers' welfare (Bhattacharya, 2016).

To conclude the analysis conducted by Bhattacharya (2016), a company can take two different routes. (Figure 5.)

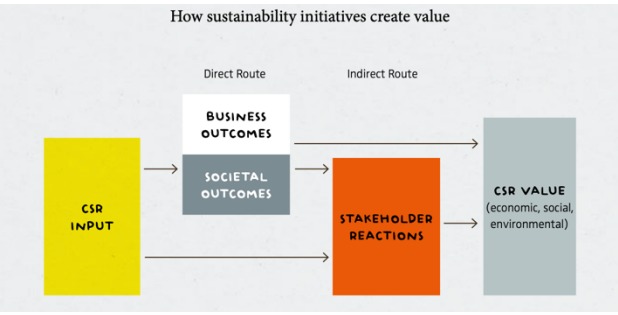

Figure 5. How sustainability initiatives create value (Bhattacharya, 2016)

Either invest in sustainable, green projects which would increase its business value and profit in the future, or it can increase its value creating by putting focus on the stakeholders' response. If the corporation becomes more sustainable and eco-friendlier, then their customers would be more likely to continuously purchase their products, as that is one of the main criteria which they decide whether to buy something or not nowadays (Bhattacharya, 2016).

3.6 ESG Criteria

Over the last few years, incorporating ESG practices into the operations of companies, has become more commonly seen to some degree because of Corporate Social Responsibility (Minkkinen et al., 2022). ESG is an abbreviation which stands for Environmental, Social, and Governance criteria, and these are the aspects which are taken into account when an investment into a certain company is being considered (Minkkinen et al., 2022). How that works is, businesses' sustainability is evaluated based on these criteria and when the data is collected, a decision about whether to invest in them or not is made (*ESG Definition - Sustainable Investing*, 2022).

Environmental criteria touch upon the issues in relation to the world surrounding us, the natural resources, as well as the impact that the companies have on the environment throughout the course of their operations, both positive and negative, and in case of negative one- how they try to reduce it (Minkkinen et al., 2022). The social dimension relates to the way in which a company treats its employees, as well as in what way do the operations within this corporation affect the stakeholders, customers included (Minkkinen et al., 2022). Finally, the governance aspect relates to accrediting and adding up to the ethical conduct of the corporation, in order to ensure that a good corporate governance is run through all aspects of the business (Minkkinen et al., 2022.

A great emphasis has started to be put on companies and the society about being sustainable, here is why, many of the big corporations have started seeking ways to achieve this, reducing their footprint and negative impact on the Earth, while simultaneously reporting about it (Sætra, 2021). One of the purposes of the ESG projects is to generate assurance between the stakeholders and the companies, and for this closeness to happen, companies should outline their sustainability projects, in relation to the Sustainability Development Goals (SDGs), shown in Figure 6 (Sætra, 2021).

Figure 6. SDG through the lens of ESG (Sætra, 2021)

"The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity" (*Sustainable Development Goals | United Nations Development Programme*, 2022). There has been attempts made to link the SDGs with artificial intelligence and some of the most recent ones turned out to be a success (Sætra, 2021). With the help of AI, big data can be effectively analyzed, leading to insights into

how to achieve the sustainable development goals, which are also impacting the ESG investment projects (Sætra, 2021). Artificial intelligence can also be utilized to help with waste management, energy efficiency, and forecasting ecological impacts (Sætra, 2021).

4. AI-SUSTAINABILITY EFFORTS IN THE AUTOMOTIVE INDUSTRY

4.1 Research design

The method of analysis used for this bachelor thesis would take the form of archival research. The invention of the Internet, and the fact that nowadays it is open and accessible for everyone, makes it a perfect prerequisite for information to be flooding from everywhere and be reached by everyone.

As archival data is considered all the data that is being collected before an actual research is conducted, it is being stored for later use (Das et al., 2018). "Archival data may include census data, court proceedings, patent office records, credit histories, and educational records, among others. Organizational archives may consist of corporate annual reports, personnel files, and survey responses undertaken at different times" (Das et al., 2018).

Throughout the course of research for this bachelor thesis, data from various sources have been collected and analyzed. For the first part- the theoretical framework, academic journal articles have been the main source of information. The researched articles have been accessed through websites such as Mendeley, Scopus, Elsevier, ResearchGate and Emerald. The keywords that have been used for the data collection include but are not limited to: "ESG projects", "Artificial Intelligence", "Corporate Social Responsibility", "automotive industry", "machine learning", "sustainability". In terms of the second part of the report- the analysis of the data, the focus goes more onto non-academic literature. That includes automotive industry online magazines and journals, as well as companies' websites, where information about their projects, breakthroughs, and annual reports is presented periodically. The keywords used for this part correspond with the ones mentioned above, as everything in the report is correlated with one another.

The overall research's structure would go along with the following path: first an introduction to the main topics AI and ESG would be made, followed by the research objective and how this analysis would add value to the already existing materials. Next, under the theoretical framework part, the main terms such as sustainability, artificial intelligence, CSR, and ESG would be explained in depth, next to an explanation about how they are interconnected and dependent on each other. In the following part- the analysis, an overview of the automotive industry would be presented, as well as the sustainability efforts of the car companies Tesla, Ford, Audi, BMW, Porsche, and Mercedes.

The above-mentioned businesses best represent the global market share of car manufacturers. According to research conducted in 2021 (Beauloye, 2021), BMW was the world's top selling brand, with 2,521,525 vehicles sold worldwide (Bekker, 2022d), followed by Mercedes with 2,054,962 (Bekker, 2022b), and Audi with 1,680,512 (Bekker, 2022c). Although Tesla comes at the fourth place with production of 930,422 cars (Bekker, 2022a), it has been ranked as the world's best-selling electric car manufacturer (Njuguna, 2022). Since these four car brands are the biggest representation of the global market share, a research based solely on them could be considered as sufficient to make a generalization.

As an end to this report, in the conclusion section, an answer to the research question would be given, next to a comparison of the projects of the abovementioned companies.

4.2 Sustainability efforts by companies

4.2.1 BMW Group

Bayerische Motoren Werke AG, also known as the BMW Group, is a company established more than 100 years ago, in 1916, in Germany by Karl Rapp and Gustav Otto (History, n.d.). It had first started as an airplane engine company, however, shortly after, it converted to automobile manufacturing, making them one of the most successful and high-class vehicles manufacturers in the world (Belyh, 2019).

The BMW group is putting sustainability and proper resource allocation in the middle of the company's strategic vision, as one of their main goals is reducing their CO2 emissions by half by the year 2030 (BMW Group Makes Sustainability and Efficient Resource Management Central to Its Strategic Direction, 2020). Having in mind that the company produced a total of 2.5 million vehicles in 2019, the reduction they are striving for equals more than 40 million tonnes of CO2 (BMW Group Makes Sustainability and Efficient Resource Management Central to Its Strategic Direction, 2020). Furthermore, some of their biggest goals are with reference to electromobility, circularity, environmental and social standards, employees, and society (BMW Group - Sustainability - Our Goals, n.d.). On top of their endeavours to make all their vehicles' parts fully reusable (circularity), BMW is striving towards a colossal enlargement of their electric automobiles' assortment (BMW Group - Sustainability - Our Goals, n.d.).

Looking at their next three desires as well- environmental and social standards, showing affection towards their employees, and being responsible towards the society (BMW Group - Sustainability - Our Goals, n.d.), it can be observed that all their goals align with the SDG goals through the prism of ESG (Figure 6.).

Furthermore, the BMW Group puts great emphasis on artificial intelligence, and when combining it with their sustainability efforts, they are striving to make customers' lives easier, greener, and all in all better. As said by the head of their "Project AI", Michael Würtenberger: "Artificial intelligence is the key technology in the process of digital transformation. But for us the focus remains on people. AI supports our employees and improves the customer experience" (Automotive World, 2020).

Although BMW does not have so many sustainability projects, they do have one massive one which makes up for the absence of other smaller ones, leading them along the journey towards being the most sustainable vehicle manufacturer amongst all (*IAA MOBILITY: BMW on the Way to Becoming the World's Most Sustainable Automaker*, n.d.). One of the biggest large-scale projects of the BMW Group is the BMW iFactory- the world's first ever fossil-fuel free plant (ESG News, 2022). It is being built now in Hungary, and the production of the first electric vehicles there is expected to begin in 2025 (Balkan Green Energy News, 2022).

To meet the expectations of the society in terms of adeptness, sustainability, and modernization, BMW decided to come up with this method of automatizing their production processes, making themselves even more flexible and resourceful than before (Automotive World, 2022). The mission of their new project is LEAN, GREEN, DIGITAL, and it reflects the three aspects which BMW strives to draw attention to with this undertaking (Automotive World, 2022).

LEAN appertains to flexible and well-organized production (Automotive World, 2022). Not only is BMW planning to kickstart the manufacturing process of their entirely electric vehicles, but they are planning on executing it in such way that it

aligns with the company's goals and views. With that being said, the central theme of the LEAN aspect turns out to be "highly flexible, efficient production through streamlined processes in competitive structures" (Automotive World, 2022). The flexibility of BMW vehicles' production is expressed in this that their production lines are arranged in such a way that multiple different parts can be produced at the same time on the same production line. As a result, the customers have the freedom to change a part and customize their vehicles up to six days before the actual manufacturing process. What BMW is trying to achieve with their flexibility efforts is that they want to collect real-time data, with the help of which they can track the production process more up-close and control the supply chain, inventory management, and quality of their products, as well as react fast to the inconsistency in the markets (Automotive World, 2022).

The GREEN aspect of this new production plant focuses entirely on the sustainability across the whole activities range that the BMW iFactory is going to provide (Automotive World, 2022). "Environmental, economic and social responsibility are inseparable, and we strive to achieve all three not only in the product itself but along the entire value chain". That is what the Board Member for Production of BMW Milan Nedeljković clarified in terms of what the GREEN view of their project is and what are they aiming to bring about with it.

Finally, the DIGITAL strand of the project is all about the technological advancements within the company (Automotive World, 2022). By elevating data consistency throughout all production activities and process chains, the BMW Groups is promoting the expanded use of digital technologies. According to Milan Nedeljković, the innovation and effectiveness act in accordance with each other, leading to increased need of further digitalization.

The production of the vehicles makes use of the most up to date technological advancements in the face of artificial intelligence, such as recording the production site and factories in 3D and then later using it to make planning when you are not actually on the plant. This leads to cost-effectiveness, as well as reduced production time and unnecessary investments (Automotive World, 2022).

At this moment, BMW is making use of more than 200 AI-based applications, with the help of which they can improve their decision making in case of problem occurrence, as well as automate their manufacturing processes for better quality of their products (Automotive World, 2022). One of the applications is called NVIDIA, and by utilizing it, the BMW Groups blends the newest technologies with its advanced mindset and process knowledge. This is expressed in a real-time collaboration between various locations around the globe, through virtualization (*We Are All Designers of the BMW iFACTORY.*, 2022). According to research from ESG News (2022), "the spectrum of digital applications will also include edge computing, data analytics, 5G location technologies and autonomous smart logistics systems with AI functions."

The BMW Group is also utilizing artificial intelligence through using Prewave (Meinke, 2022). Prewave is an Austrian startup company, specializing in reducing supply chain risks to minimum. The software helps BMW identify possible bad case scenarios, including environmental pollution. This is highly applicable to BMW, as they identify themselves as one of the most eco-friendly automotive companies and having a software like that working for your benefit, only brings you one step closer to achieving your sustainability-related goals and plans.

Finally, in terms of BMW's electrified vehicles, the company is trying to come up with ways to take advantage of artificial intelligence in such a way, that it would help with cutting out carbon emissions (*Our Responsibility. Our Future.*, 2021). In their sustainability report from 2021 it is mentioned that the company is still in the process of researching the circumstances and trying to shift their vehicles into being more fuel efficient and modified in such a way that they would fully suit the needs of the contemporary society (*Our Responsibility. Our Future.*, 2021).

4.2.2 Tesla

Tesla was founded by Martin Eberhard and Marc Tarpenning in 2003 under the name Tesla Motors, named after Nikola Tesla (Schreiber, 2021). The initial conception of the company was to manufacture only electric vehicles, and their first ever project in mind was to develop an electric sports car. Interestingly, even though it is commonly thought that Elon Musk was the founder of the company, he was only their biggest sponsor at the beginning, contributing with more than 30 million US dollars to their new project. Starting in 2004, Musk was appointed as a chairman of the company, and 4 years later, in 2008, he became the CEO (Schreiber, 2021).

The mission of Tesla as of this day is "to accelerate the world's transition to sustainable energy" (*About Tesla | Tesla*, n.d.). On top of manufacturing only entirely electric vehicles, the company strives for creating a complete ecosystem for sustainable energy. It does that by manufacturing energy solutions like "Powerwall, Powerpack, and Solar Roof", which help the society with making use of renewable energy (*About Tesla | Tesla*, n.d.).

Tesla has always been thought to be the leader in environmental sustainability and a leader in the electric vehicles production. They have consistently strived for higher efficiency, as well as a more cautious and greener driving experience. Hence, they have introduced to the public the Robotaxi (Banik, 2022), which is one of their most recent sustainability projects. The Robotaxi is a self-driven car without a wheel or pedals, ass it is meant to fully substitute human drivers (Templeton, 2022). The purpose behind this Robotaxi is to shift the perception of people on car ownership. According to them, in the future, owning a Tesla of any kind would make money for you, rather than cost you anything, and they wanted to prove it with the invention of the Robotaxi. The way this new project works is that they make use of both company-owned and customer-owned vehicles. For instance, they hire your Tesla from you when you are not using it, convert it into something like the Model 3, and equip it with all the necessities to be a self-driven taxi (Templeton, 2022).

However, as much as it looks like the focus of this project is on sustainability, cutting back on fossil fuels, and in general reduction of the negative impact on the environment, that is not necessarily true (Klender, 2022). Even though Tesla mentions those points in their 2021 Impact report, the focus happens to be on minimizing costs for customers and maximizing their potential income coming from giving out their vehicles. Still, the Robotaxi will in fact contribute to more efficient use of vehicles (Klender, 2022), as this is something demanded also by the government, but the major aim of Tesla, regarding the Robotaxi, was to "mitigate rather than solve environmental issues"

The popularity of electric and hybrid vehicles has never been higher due to the 2030 prohibition on traditional fuels in new vehicles and the present increase in fuel prices.

When a person hears "Tesla", most probably one of the first things that comes to their mind is sustainability. And even though the company manufactures only electric vehicles, a study conducted in 2022 indicates that Tesla takes the last place and ranks at the bottom of the list of the most sustainable automobiles in 2022 (Boratyn, 2022). Tesla ranks 17th on this list since one of

the main criteria is Corporate Social Responsibility score. The company scores only 40 on this aspect, which turns out to be relatively low in comparison to 92, scored by Peugeot for example. What is more, the cheapest Tesla model appears to cost 783 GBP per 12 000 miles. Compared to the most efficient Smart car model, which costs only 206 BGP for the same distance, that results in a 117% difference in price, which only exacerbates the situation Tesla finds itself now (Boratyn, 2022).

4.2.3 Mercedes-Benz

Mercedes Benz is one of the 5 companies, operating under the Daimler Group (Editor, 2019). It was founded in 1926 by Carl Benz and Gottlieb Daimler under the name Daimler-Benz, and the motto of the company, chosen by Gottlieb Daimler, remains to this day "Das beste oder Nichts", which literally translates "The best or nothing". The headquarters of the company are in located in Stuttgart, Germany, and their cars are manufactured in 17 countries on 5 different continents nowadays, however, sold all over the world (*About Us*, n.d.).

In 2020, on the Consumer Electronics Show (CES) in Las Vegas, Mercedes-Benz presented their vision for a sustainable, zero-emission vehicle, and that is the VISION AVTR (Seredynski, 2022). The car was presented by Chairman of the Board of Mercedes-Benz, Ola Källenius, as a fully electric configuration intended to be "in harmony with people and nature, which links it to the first part of the report, where CSR, ESG, and the Triple bottom line were brought in. The VISION AVTR utilizes entirely recyclable battery configuration, as well as takes advantage of artificial intelligence to amplify effectiveness and overall performance (Seredynski, 2022). According to Ola, "the philosophy of reduce, reuse and recycle will lead us to our ultimate goal: the zero-impact car – a car that uses technology to provide maximum fascination for people but has zero negative impact on the planet" (Seredynski, 2022).

As the name suggests, the inspiration for the vehicle's novel design is taken from the movie Avatar, which can also be observed based on the "one bow" arrangement of the machine. In the car, there is no steering wheel, but rather a console in between the two seats. When the owner steps into the car, it can recognize him by his heartbeat and breathing style and pattern, and it responds to his commands by detecting his hands' movement.

Although this vehicle would most probably never be built, the purpose it served was to show and prove to society that a future where technology, sustainability, and humans can exist and operate harmoniously (Seredynski, 2022).

4.2.4 Audi

The car company Audi have come a long way before becoming what it is today. More than 100 years ago, in 1899, August Horch founded his first company August Horch & Cie in Cologne (*History*, 2022). 10 years later, in 1909, he established another one- Zwickau, which has been working under the name Audiwerke AG, Zwickau from the next year, which marked the actual appearance of the current name of the company. Later, in 1932, four automobile manufacturers- Audi, DKW, Horch, and Wanderer, merged in Auto Union AG, which is what the logo with the four rings of Audi symbolizes (*History*, 2022).

The logistics networks and activities of an automotive company typically consist of many complex operations. Here is why, it is crucial for companies to be aware of the risks that they might encounter while executing these operations (*Supply Chain Monitoring: Audi Uses Artificial Intelligence (AI) for Sustainability*, 2021). Audi's intentions are to put even more focus on their sustainability efforts, but this time through "digital supply chain monitoring". This includes making sure that all the suppliers of Audi are complying with certain requirements, specified beforehand.

For example, in the "Code of Conduct for Business Partners" the company has specified what these requirements are and keeps an eye on the suppliers, in case a violation occurs. The same suppliers are distinguished from one another with a sustainability rating (S-rating), which helps Audi decide on which suppliers they want to conduct agreement with. Since October 2020, they are counting on artificial intelligence for their supply chain operations. The machine learning algorithm helps the company execute the monitoring in 50 languages in 150 different countries. Just like BMW, Audi is using the Austrian software Prewave, which helps them with overall risk assessment way faster and more accurate than if it would have been done by a person, which is one of the reasons why Audi relies so heavily on it. When the risk is identified on time, it can be mitigated on time, saving the company from many troubles and losses. Using artificial intelligence with a thought towards the company gives it a competitive advantage over other companies with less interest towards sustainability, as nowadays almost everyone tries to be eco-friendly and would most of times prefer and choose the greener option in each aspect possible (*Supply Chain Monitoring: Audi Uses Artificial Intelligence (AI) for Sustainability*, 2021).

5. CONCLUSION

Many of the car manufacturers have started thinking towards a sustainable future achieved with the help of artificial intelligence, however, not many of them have not implemented these thoughts in their projects yet. Tesla for example has already developed an autonomous vehicle, which is simultaneously cutting back on unwanted emissions, although the driver must still be in the car while it is in motion, in order to avoid unpleasant accidents (ETX Daily Up, 2022).

The automotive industry is already exceeding society's expectations from years ago, however, there is potential for so much more, which is luckily already possible with the help of artificial intelligence. It is expected that the global self-driving vehicles market will grow from 5.6 billion dollars to 60 billion dollars in just 12 years- from 2018 to 2030, while simultaneously machine learning is steadily making its way into the future innovation projects of the automotive leaders (Bisnoff, 2022).

There is plenty of easily accessible information on the internet regarding IT and artificial intelligence and how can they complement sustainability in the automotive industry, however, most of it seems to be only a speculation for the future and not something being implemented by car manufacturers now. Nevertheless, artificial intelligence is only in the beginning of its journey, and over the course of the next decade it is expected that its importance would be booming (Leggett, 2022).

In terms of answering the research question, the findings from the research surrounding it have turned out to almost support fully what is written in the previous paragraphs. All four companies- BMW, Tesla, Mercedes, and Audi are leaders in the respective industry, hence, the expectations from the society towards them are even bigger. People are expecting that all the conversations, reports, and investigations about being more eco-friendly would have impacted the companies' ways of executing their operations. However, this is not a process happening overnight, both artificial intelligence and sustainability are the fruit of much work and thoughts involved, and even though they are extremely important by themselves, combining them into complex projects would most probably take a lot of time and planning from the companies.

However, this does not mean that these businesses do not have a single project in respect to the purpose of this report. What the research have shown is that all the companies seem to strive for similar goals- reduction of CO2 emissions and mitigation of sustainability supply chain risks. A common solution to these problems turns out to be an artificial intelligence software Prewave, designed intentionally to serve the purpose of minimizing supply chain risks. What is more, cutting the bad emissions is achieved by the companies through designing modern and novel vehicles, with technologies which have never existed until this moment.

An interesting finding from this research turns out to be the fact that Tesla emerges as the least sustainable car company, which is not in harmony with how they are presenting themselves to the society. That is a good indication that no matter what you think you are doing for the environment, and how well-intended you are towards it, if you mess up even on a single aspect, as is the case with Tesla and Corporate Social Responsibility, you could find yourself on the bottom.

Although being part of the initial proposal for this bachelor thesis, information and analysis of Ford and Porsche would be omitted from the research not only due to time constraints, but most importantly because of shortage in the publicly available materials by the abovementioned companies.

Although sustainability and artificial intelligence are concepts of great significance which are being talked through daily by the biggest corporations all over the world, there is limited research done on the combination of both aspects, utilized in the same company projects. What is more, neither Ford, nor Porsche had any specifically related to the topics of this thesis articles. That is why, leaving them out of the research would not vitiate the quality of it in any way. At a later stage, when the respective companies have already released information about their intentions on how to become more sustainable through artificial intelligence, this information could be used to complement the study for even more in-depth observations.

However, it is important to be mentioned that even though artificial intelligence is not part of the ESG projects of these companies, both are contributing towards a greener future and are reflecting on the possibilities of becoming more sustainable with time.

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