IMPACT OF THE FACTORS OF THE GREEN DEAL TO SMART MOBILITY

[a]ROBERT VON BÖHLEN, [b]IVETA ŠIMBEROVA

Brno University of Technology, Faculty of Business and Management, Kolejní 2906/4, 612 00 Brno, Czech Republic
email: [a]232577@vutbr.cz, [b]simberova@vut.cz

Abstract: The Green Deal aims to protect the environment and has a significant impact on the automotive industry. The Smart Mobility approach makes it possible to better implement sustainability in the automotive industry. This thesis examines the impact of the Green Deal on smart mobility. After a methodical literature research and an online survey, which was evaluated with linear regressions, the thesis comes to the conclusion that Smart Mobility and the Green Deal are strongly interrelated. Sustainable change in the automotive industry will probably not only be achieved through electromobility, but also requires new mobility concepts.

Keywords: green deal, smart mobility, digital transformation, business model

1 Introduction

The Green Deal aims to protect the environment and has a significant impact on the automotive industry. The Smart Mobility approach makes it possible to better implement sustainability in the automotive industry. This thesis examines the impact of the Green Deal on smart mobility. After a methodical literature research and an online survey, which was evaluated with linear regressions, the thesis comes to the conclusion that Smart Mobility and the Green Deal are strongly interrelated. Sustainable change in the automotive industry will probably not only be achieved through electromobility, but also requires new mobility concepts (Rukanova et al., 2023). The EU is to be transformed into a modern, resource-efficient and competitive economy. The aim is to achieve climate neutrality in the EU by 2050. At the same time, economic growth is to be decoupled from resource consumption (Vinodh, Jayakrishna, 2013). The EU also focuses on the entire life cycle of products (Thormann et al., 2023). Other factors, such as water consumption, must also be taken into account in the production of cars (Semmens et al., 2014). The ecological footprint of the automotive industry needs to be reduced in many areas. Manufacturers' own reporting on sustainability is often difficult to verify and lacks transparency, so there is still room for improvement here too (Molnár et al., 2023). At is also difficult for public authorities to access the relevant data (Rukanova et al., 2023). According to the Paris Climate Agreement, global warming should be slowed to below 2 degrees Celsius, preferably 1.5 degrees Celsius (Konewka, Czuba, 2022). This also results in the need to combine sustainable and intelligent mobility. It can be assumed that sustainable mobility also requires intelligent mobility in many areas. Simply replacing combustion vehicles with electric vehicles is only an improvement in terms of local CO2 emissions. In many areas, sustainable and environmentally conscious mobility solutions are only made possible by intelligent mobility and the digital transformation. The aim of this article is to answer the research question:

"To what extent do the specific measures and objectives of the Green Deal influence the acceptance and implementation of smart mobility solutions among automotive customers in terms of environmental friendliness and sustainability?"

Nevertheless, we must first consider the CO2 emissions from the transport sector. In 2020, the Covid-19 pandemic also helped to reduce emissions in the transport sector by 13 percent. However, car manufacturers have suffered considerable losses during the coronavirus pandemic (Kucera, Ticha, 2021). The European share of global CO2 emissions from transportation amounted to around 15% in 2020. Other global emitters such as the USA and the South Pacific region account for around 30% and 33% respectively. Within the EU, transportation accounts for 25% of total CO2 emissions. Passenger cars and light commercial vehicles account for 12% and 2.5% of total CO2 emissions in the EU respectively. Electric vehicles therefore have a significant role to play in reducing the respective greenhouse gas emissions. In their work, Konewka and Czuba assume that electromobility will create a kind of new industry within the EU. The known supply bottlenecks also meant that customers were more likely to buy hybrid and electric vehicles, as these were prioritized by manufacturers. In 2021, the share of electric and hybrid vehicles was already 19.2% compared to 11.4% in the previous year (Konewka, Czuba, 2022). In their agreement in Rome, the European member states also adopted a common transport policy. The focus here is on the harmonization of this policy, whereby this mainly relates to legal, technological, social and fiscal aspects (Konewka, Czuba, 2022). It is also important for companies and large manufacturers to recognize their own responsibility beyond political or public pressure and to work on these issues with intrinsic motivation, so that innovations and improvements can be made along the entire value chain (Broch et al., 2015). Other studies come to the conclusion that companies should create their own innovation culture (Troise et al., 2022).

In addition to looking at CO2 emissions, it is also important to clarify the economic importance of the automotive industry within Europe at the beginning of this paper. In 2021, around 12.7 million people were employed directly or indirectly in the industry, which corresponds to around 6.6% of total employment in the EU. Production alone employed 2.6 million people, making the automotive industry important for the economic stability of individual countries within the EU (Traverso et al., 2015). The most important sales regions for the automotive industry are the EU itself, the USA and China. In 2021, 9.9 million cars were produced and 9.9 million cars were registered within the EU. This corresponds to 16.1% of global production and 15.7% of global registrations. However, the figures for 2021 must be viewed somewhat more critically, as the figures were lower due to the coronavirus pandemic and global shortages of materials and chips. The figures for 2022 were also only around 10.9 million cars produced in the EU, compared to around 15.8 million before the coronavirus pandemic (Konewka, Czuba 2022).

As part of the Paris Climate Agreement, the Green Deal aims to achieve the climate protection targets more quickly and also states that economic benefits can be achieved by achieving the Green Deal. By 2030, the EU is to reduce its CO2 emissions by 55% compared to 1990 levels. Originally, a reduction of only 40% was planned. Car manufacturers and mobility providers have a duty to provide answers to these questions. Traffic-related emissions are now higher than in 1990 (Haas, Sander, 2020). Car manufacturers must now focus on electromobility and / or hydrogen drives in order to meet the new targets. It has become a balancing act for politicians and car manufacturers to find the optimal solution between the challenges of environmental protection and the economic goals of companies. However, this is also where the approaches for smart mobility arise, which can have a positive influence here (Reichenbach, 2020).

Under the Green Deal, the EU should have achieved climate neutrality by 2050. Emissions trading in the EU also plays an important role in this. The aim is also to strengthen emissions trading within the EU through a sensible carbon price (Claeys et al., 2019). In the transport sector, this can only be achieved through predominantly electrification or suitable hydrogen vehicles. Trading in emissions certificates is also at the heart of the Green Deal. The price of CO2 will rise continuously over the coming years. It should also be noted that climate protection targets are being tackled to varying degrees around the world. The Green Deal further intensifies the different ambitions with regard to climate protection. It should also be noted that the achievement of climate protection targets must not be accompanied by a deterioration in the EU's competitiveness. In the view of many scientists, this is one of the greatest challenges in implementation. In the opinion of many researchers, a stronger focus goes hand in hand with a deterioration in international or global competitiveness, as more climate protection often has a negative impact on economic performance. In the field of automobility, this specifically means that synthetic fuels must also be prioritized more strongly. At the same time, Löschel believes that an even greater focus will have to be placed on product and process innovations (Löschel, 2020). In their 2023 study, Yi et al. found that the state and politics in particular have a very large influence on the achievement of climate protection targets (Yi et al., 2023). Even well thought-out individual measures, such as optimizing the vehicle paintwork, can already save a lot of CO2, whereby this can already be around 24% in the case of paintwork (Wendt et al., 2023). At the same time, however, it must also be noted that even sustainable products continue to emit CO2. Wind turbines and modern electric cars also require steel, metals and plastics for their manufacture and production. According to Wyns and Khandekar, it can be assumed that the sustainable transformation is tantamount to an industrial revolution (Wyns, Khandekar, 2019).

In addition to the research question already mentioned, three topics were to be examined in particular with regard to the users. These include the change in transport behavior, the acceptance of new technologies and the development of environmentally friendly transport solutions.

2 Literature research

The literature research for this paper shows that there have been no specific studies to date on the effects of the Green Deal on smart mobility. However, there are various works that deal individually with the topics of the Green Deal and smart mobility. The relevant findings from this literature research are now summarized here as follows.

2.1 Green Deal

This also raises the question of what the Green Deal means for the automotive industry in concrete terms. As part of the Green Deal, car manufacturers must reduce average CO2 emissions by 37.5% between 2021 and 2030 (Wyns, Khandekar, 2019). In their analysis from 2020, Haas and Sander come to the conclusion that accelerated ecological modernization instead of a socio-ecological transformation is the right way to positively realize the implementation of the Green Deal. In their study, they also come to the conclusion that limiting the fleet thresholds is neither aimed at reducing the volume of traffic nor at a shift towards environmentally friendly modes of transport. In the view of Haas and Sander, a far-reaching change in transport policy is necessary. The ecological improvement of cars therefore has little effect on an actual change in the traffic situation. As a rule, German car manufacturers in particular have not been very ambitious in pursuing fleet limits in recent years. At the same time, the scandals of recent years, such as the diesel scandal, have not helped to improve the image of the industry (Wellbrock et al., 2020). At the same time, the regulations contain many exemptions, which is why there has hardly been any reduction in real emissions values. Haas and Sander also stated in their 2020 paper that the success of the European Green Deal also depends heavily on the various strong forces of lobbying. The automotive industry in particular continues to have a very strong lobby. However, it is clear from their analysis that the transport sector in particular needs to change. Based on the work of Haas and Sander, there is also a need for further research, which can be answered here in the context of this thesis. The influence of the Green Deal on smart mobility also raises the question of whether sustainable and ecological change in the mobility sector can also be achieved by changing the awareness of users and people with regard to the entire transport situation. It therefore remains questionable at present whether a pure focus on ecological factors is sufficient to actually implement the necessary measures of the Paris Climate Agreement and the Green Deal? Furthermore, Haas and Sander also address the aspect that the transport sector is already facing major changes due to digitalization and automated driving (Gidebo, Szpytko, 2020). Haas and Sander's recommendation that mobility should be placed more strongly within the framework of social relationships is also interesting for further research in the context of this study. The questions of the Green Deal also go hand in hand with questions of mobility justice. This aspect must also be taken into account, as electric cars in particular are currently still more expensive than classic combustion vehicles (Haas, Sander, 2020). Compliance with EU legislation in terms of solidarity, sustainable development and a high level of environmental protection must also be achieved (Sikora, 2021).

The effects of the Green Deal continue to be of great importance for electromobility. From the EU's perspective, passenger cars and light commercial vehicles are also a strong driver of innovation, efficiency and competitiveness with regard to the Green Deal. However, the implementation of electromobility also requires a high degree of further implementation in the countries, particularly with regard to the appropriate charging infrastructure. Countries in which there is a high level of social understanding for environmental protection are particularly successful in this regard. In their work, Konewka and Czuba also come to the conclusion that governments must promote the purchase of electric vehicles with subsidies, discounts and incentives. New providers and start-ups will enter the electromobility market and thus promote new technologies. In this context, battery costs in particular should be further reduced through new technologies. Konewka and Czuba also assume in their work that understanding customer needs will become a key issue. This is particularly relevant for markets in which a new product is to be launched. From the perspective of this study, the question also arises as to whether smart mobility can be used positively for customer understanding with regard to sustainability and the Green Deal. Konewka and Czuba assume that the uncertainties regarding the electric cars to be introduced go hand in hand with potential customers' acceptance of the new technology. Customer acceptance remains one of the most critical issues in the development of further sustainable drive systems (Konewka, Czuba, 2022). Rafieefar also points out in her work that the political focus is very much on electromobility, but that other topics and ideas that can be achieved through digitalization and sustainability tend to be largely ignored, even though they may have even greater ecological and social benefits (Rafieefar, 2022).

In another study by Peyravi, Peleckiene and Vaičute, the authors come to the conclusion that technological progress is the main criterion for reducing climate change in the vehicle sector. In addition, the authors believe that public administration is called upon to improve alternative usage concepts and the like in such a way that electric vehicles and other mobility options are used more effectively (Peyravi et al., 2022). Omahne, Knez and Obrecht also assume in their analysis that sustainability and electromobility will become one of the most important topics in the area of sustainable cities and municipalities in the future (Omahne et al., 2021). The work of Omahne, Knez and Obrecht is also interesting in that it shows specifically in which areas the topic of electromobility and the Green Deal has not yet been sufficiently researched. An extensive literature review was carried out as part of their work. This made it clear that there is a lack of literature to date on the effects of electromobility on social well-being and the user experience. The general acceptance and perception of electric cars has already been studied extensively, although the image of electric cars, specifically their perception as a status symbol, has not been studied very intensively. Overall, it can be seen that the literature often fails to provide a comprehensive analysis of electric mobility and thus also of social measures. The investigation of social readiness is also very important here, as the increasing spread of electric cars also goes hand in hand with the positive perception and acceptance of the population (Omahne et al., 2021). However, the analysis by Omahne et al. also made it clear that it is precisely those cities and countries in which the political requirements, such as the EU's Green Deal, are being implemented in a focused manner that are paying more attention to electromobility. Their work also makes it clear that the connection between sustainability and affordable energy as well as affordable electric mobility has not yet been investigated much, although this is certainly indispensable for a large part of the population. In the current literature, the topics of user experience, social readiness and welfare are also missing when considering electromobility (Omahne et al., 2021). At the same time, increasing competitive pressure requires the digital transformation of the industry anyway (Singh et al., 2021). Other studies also come to the conclusion that digital transformation is positively linked to company performance (Chouaibi et al., 2022). In their work, Llopis-Albert et al. discuss how the automotive industry is being disrupted by the digital transformation. This includes aspects such as connected and autonomous driving, digital sources of information when buying a car, big data and electric vehicles, but also mobility as a service, where car ownership is increasingly being pushed into the background (Llopis-Albert et al., 2021). Li and Yang's analysis comes to the conclusion that modern large corporations and manufacturing companies can no longer succeed in the digital transformation alone. Cooperation is therefore becoming increasingly important. Large corporations in particular should increasingly focus on technological innovation and the introduction of new technologies (Li, Yang, 2021). Furthermore, the technological innovations of individual companies also have positive effects on the overall economies of the respective countries. Economic expansion therefore also leads to greater prosperity and a higher level of employment across the board (Galindo-Martín et al., 2019). The analysis by Li et al. has made it clear that companies that consider digital transformation are more likely to have a digital technology infrastructure and a strategic focus on digital infrastructure. This also enables these companies to respond better to environmental turbulence in the market (Li et al., 2021).

Energy sources for electromobility are being promoted for modern drives in particular. The study by Llopis-Albert et al. comes to the conclusion that manufacturers will ultimately have higher profits, productivity and competitive advantages if the digital transformation is implemented. For consumers, the authors of the study expect better and more services and greater satisfaction. The authors also assume that the nature of new products and new services in the automotive market will be favored by government legislation on environmental issues and high consumer demand anyway. The study also comes to the conclusion that all stakeholders expect improved or new digital offerings in order to achieve greater satisfaction. The focus of these offers is often specifically on cost-effective, economical and autonomous electric cars that take into account the use of efficient renewable energy sources. According to Llopis-Albert et al., companies with a leading role in digital offerings in the automotive industry will gain a competitive advantage. From the authors' point of view, investments in these areas are therefore sensible and quickly profitable. At present, however, companies are still cautious about investing in digital transformation, as investments generally require a certain amount of time to generate a return and still always entail a certain degree of uncertainty. Customer satisfaction is usually assessed in terms of product satisfaction, accessibility, connectivity and simplicity, as well as cost and delivery capability. It should also be noted that it is precisely the power of consumers and customers that is strongest, as they ultimately have the power to decide whether or not to buy a vehicle or product. For consumers, the high vehicle costs, long charging times, the short vehicle range and the scarcity of charging stations continue to be the main obstacles to buying a hybrid or electric car. Improvements in these aspects as well as additional lower energy costs, emissions, higher energy efficiency, low repair and maintenance costs and special parking spaces as well as tax incentives can be aspects that significantly improve consumer interest in electric cars. At present, there are still competing interests among stakeholders, which is why the introduction of electric cars has been slow (Llopis-Albert et al., 2021).

Digital transformation also focuses primarily on increased customer benefit, whereby digital business models are also intended to create great value for companies. In turn, digital transformation also helps to link customer requirements with the relevant specialist knowledge and empirical findings. This allows business models to be aligned even more precisely with the respective needs and market requirements (Lee et al., 2021).

Overall, the following aspects continue to have a strong impact on the automotive industry and will continue to do so in the future, thus encouraging the industry to focus more strongly on the Green Deal and its own environmental responsibility. These include, among others: Exponential population growth, new markets and new consumers and also presumably the further increase in prosperity in the form of more cars per capita (Schönmayr, 2017).

Up to this point, many aspects of the Green Deal have already been mentioned and discussed. The question now arises as to what exactly the connection between smart mobility and the Green Deal is. It can be assumed that the precise measurement of climate change and the concrete evaluation of weather data has only become possible thanks to digitalization and the associated measures. As a logical consequence, the approaches of the Green Deal have also emerged. The challenges currently facing mobility have already been mentioned. The smart mobility approach then opens up the corresponding potential uses for overcoming the challenges of mobility accordingly.

2.2 Smart Mobility

The term "smart mobility" covers several areas of modern mobility, some of which are referred to by different names. Smart mobility is referred to as intelligent mobility, mobility-as-a-service or mobility 4.0 and is also understood as autonomous driving or intermodal traffic management. The main objective of smart mobility is to provide efficient, cost-effective, safe and environmentally friendly mobility for people and goods. Smart mobility is also evaluated differently depending on the region, as the mobility requirements in rural regions are already different from those in urban centers of life. In times of rapid development of megacities with 10 million inhabitants and more, smart mobility developments have focused primarily on these. However, it is just as important to consider normal cities with regular populations as well as rural areas. In her work, Flügge raises the question of who can still rely on a mobility service at all in times of car sharing, electromobility and autonomous driving with a simultaneous scarcity of resources and outdated and high-maintenance infrastructure (Flügge, 2017). However, the current situation is such that there is an increasing problem between the desire for individual and optimal mobility and the structural and industrial weaknesses of the mobility system. In some areas, there is already talk of the system being overstretched (Flügge, 2020). Mobility is a fundamental human need that enables both contact between people and the exchange of goods. However, increasing mobility comes at an ever higher price for people and, above all, the environment. The boundaries between private and public transport will become increasingly blurred. Examples of smart mobility include automated parking, automated logistics, the autonomous last mile to the end customer, digital and connected connectivity solutions as well as digital real-time maps. In a broader sense, the connections between vehicles, people, traffic control in the form of traffic lights etc. and other mobility services are also absolutely essential. The technical infrastructure is always the basis for modern smart mobility (Baumann, Püschner, 2017). Sensor technology will make a decisive contribution to success, particularly in the areas of smart mobility mentioned above, whereby the focus is always on putting people at the center of interaction (Orecchini et al., 2019).

Various usage scenarios arise in the area of the mobility-as-a-service approach. Possible providers for this are, in particular, large automotive groups as well as public or municipal mobility providers. However, some stakeholders are currently asking themselves whether there really is a large market for this mobility service. The current literature suggests that urban and digitally savvy people in particular are more willing to use such a pure mobility service. However, the services must then be offered individually and tailored to user behavior and not as a package. However, MaaS needs to be more closely integrated into multimodal transport in order to be accepted by travelers and thus bring about a change in users' travel behavior (Karlsson, 2020).

Smart mobility could become very interesting, especially for the use of the last few meters to the destination in urban areas. Experts assume that self-driving cabs could only account for around a third of current cab costs. In their analysis, Vogel et al. come to the conclusion that the success of smart mobility depends heavily on user acceptance, which has already been mentioned several times before. A large part of the necessary transport infrastructure for sustainable smart mobility is still missing in today's inner cities. Above all, a very good infrastructure network is required to implement this. E-mobility, connectivity, mobility apps and artificial intelligence can help to significantly reduce noise and emissions locally. Piloted parking must be taken into account, as must fast lanes in the city center. Recent studies also assume that the focus of cities on cars as the main means of mobility will decline. In times of smart mobility, reward approaches and additional parking spaces for shared vehicles are also a way of making car sharing and resource conservation more attractive, and policy-makers in particular can continue to exert a strong influence on this (Vogel et al., 2018). Especially in areas where there is a high proportion of commuters, construction sites or various other mobility services such as airports, it is important to look for an adaptable strategy. Flügge therefore defines the concept of smart mobility as follows: as visionary but feasible mobility of the future. This must be applicable and usable for everyone, regardless of location and region, regardless of duration and scope of use, individual budget and abilities (Flügge, 2017). This definition can also be continued in the context of this work.

The main criticism of the current transport situation to date is that mobility has so far been thought of in silos, i.e. according to individual mobility fields such as automobility, local public transport, train travel or air travel. The second division was into private and public mobility providers or passenger and freight transport (Flügge, 2017).

When considering smart mobility in the automotive sector, however, it is first necessary to consider the car as such. Car-based systems have brought with them a high degree of accessibility, connectivity and convenience. The disadvantages of the car, on the other hand, are noise, pollution, significant land consumption, urban sprawl, urban decay and even severe isolation in some areas. At present, the car is still the main means of transportation in Europe. Freedom, prosperity and quality of life are the key benefits of the car, which in turn are offset by health problems, global warming and inefficient resource management. This is also the conclusion of the Urry study from 2004 and 2008 (Kauschke, 2023). The car is increasingly competing with other means of transportation and is increasingly seen as inefficient mobility. Smart mobility also pursues the goal of improving mobility between goods and people around the world (Flügge, 2017b). According to Flügge, the optimal mobility outcome is primarily dependent on the variables of time, budget and comfort.

At this point, the most relevant aspects that can be optimized accordingly with smart mobility must be mentioned in relation to the automobile. These include opportunity costs for all types of travel planning, heavily congested infrastructure such as roads and the like, a further increase in global freight traffic, limited space capacities, a low number of car uses due to predominantly idle times, a further increase in the global population, increased population growth, urbanization, the spread of networked systems and the increase in smart cities and autonomous cars. Urban centers in particular will become increasingly in demand, with around 50% of the world's population already living in cities. Urban planning in the sense of smart cities in combination with smart mobility is therefore becoming increasingly important (Khashoggi, Mohammed, 2023). The unequal access to mobility in both rural and urban areas will certainly also be a problem here (Flügge, 2017b). In regions where new cities are built from scratch and start from scratch, it is much easier to incorporate smart mobility solutions. As a rule, new design concepts and technologies are directly integrated there in order to implement the smart city concept accordingly. Existing cities face significantly greater challenges, as it is not easy to simply relocate roads, train tracks or subway networks (Flügge, 2017b).

In the further course, it is particularly important to work out what the specific differences will be in relation to smart mobility in the field of automobility. A number of aspects are repeatedly highlighted in different literature. From the authors' point of view, it can be assumed that car manufacturers will tend to become mobility providers in the future and put together corresponding mobility packages. The business model will tend towards a constant cash flow and away from the margin on every car sold. Public and state mobility providers will also have to revise their infrastructure and products. However, new trains and new tracks are still a long way from true digitalization. So far, digitalization has tended to take place in order to save costs and personnel, which includes the installation of ticket machines. At the same time, the specific mobility requirements of the population continue to be forgotten (Flügge, 2017c). Autonomous shuttles and multimodal transport services in combination with alternative drive systems will change the transportation sector. Baumann and Püschner assume that the boundaries between public and private transportation will blur or disappear. Innovative business models will be able to play a pioneering role here (Baumann, Püschner, 2017).

From the perspective of smart mobility in the automotive sector, the following use cases arise: smart parking in combination with autonomous public transport shuttles; smart mobility for optimized and intermodal route guidance in the transport sector; smart delivery of parcels over the last kilometer; digital route guidance for navigation users; smart communication between vehicles and traffic lights as well as public transport; optimized traffic flow; simplified travel for companies; car sharing; shared travel routes; autonomous driving (Flügge, 2017d). The availability of different mobility options is determined by the decisions of users and local providers. At the same time, the number of rules and signs in urban areas is also increasing, making it more difficult for drivers to cope (Böhm et al., 2020).

Further analysis also reveals other measures and ideas. The concept of smart mobility in combination with the Green Deal, or rather in combination with environmental protection and sustainability, is currently still a very new discussion in literature and science. It should also be noted that smart mobility is one of the six design elements of the smart city. The term Smart City is also characterized by the five elements Smart Governance, Smart People, Smart Living, Smart Economy and Smart Environment (Flügge, 2020). The terms smart city and smart mobility go hand in hand in some areas, with smart mobility benefiting greatly from smart city developments in some areas. Cities are increasingly starting to install intelligent sensor data in order to better regulate parking spaces and traffic. This data is then in turn fed into cars. At the same time, many new mobility providers, such as e-scooters and the like, have moved into cities (Nienaber et al., 2020). Cities are important for the economic upturn, as they bring together economic performance and other areas in a small space and can therefore develop a high level of strength (Gidebo, Szpytko, 2020).

However, the current situation is such that there is an increasing problem between the desire for individual and optimal mobility and the structural and industrial weaknesses of the mobility system. In some areas, there is already talk of the system being overstretched (Flügge, 2020).

Search queries for the term smart mobility have been on the rise for years and have roughly tripled over the past ten years. Interest in smart mobility is also growing in research. The definition of smart mobility is not clear in the industry. In consulting, the term revolution has been coined for this. In this context, smart mobility refers to the use of means of transportation in addition to or instead of owning a fossil-fuelled vehicle. In their definition from 2020, Ahmed et al. go further and describe the intelligence of the system's self-learning capabilities as the decisive criterion. Intelligent mobility thus primarily stands for efficient and convenient travel with a minimum of human intervention. In 2016, Mueller-Seitz et al. defined smart mobility as encompassing performance dimensions such as sustainable, innovative and safe transportation systems. Flügge already defined the numerous target dimensions of smart mobility more comprehensively in 2016. Flügge defines smart mobility as a service that enables energy-efficient, low-emission, safe, comfortable and cost-effective mobility and is used intelligently by road users. The aforementioned definition by Flügge from 2017 can therefore be supplemented with the approaches from 2016 from today's perspective. Other authors tend to separate smart mobility from the idea of sustainability in their definitions. In 2017, Jeekel defined this as user-oriented, technology-oriented, IT-oriented, development-oriented and action-oriented. Lyons stated in 2018 that smart mobility evokes a sense of new possibilities and progress. In Lyons' view, smart mobility broadens horizons and must also include sustainable mobility and liveable mobility spaces. According to Anders and Klaassen's text mining approach from 2018, smart mobility focuses on optimization rather than challenging the status quo. Based on the findings of the various authors up to this point, it is also necessary to include social and sustainability-related objectives in smart mobility (Kauschke, 2023).

Of particular interest are the findings of some studies that attribute a reduction of up to 50% to the aspects of smart mobility with regard to the potential for reducing emissions. These are the findings of the studies by Barth et al. from 2015, Jochem et al. from 2015 and Pribyl et al. from 2020. Kauschke therefore summarizes the various definitions mentioned above and redefines the term smart mobility himself, whereby in his opinion smart mobility stands for a smooth future of ubiquitous and networked transport, i.e. for an effective system that is optimized for sustainability, attractiveness and affordability and goes hand in hand with the introduction of automated and electrified vehicle systems. Kauschke also considers the environmental challenges and quality of life as well as the aspects of electrification, automation and the main goal of digitalization in the area of process optimization (Kauschke, 2023).

Bereits zuvor war kurz auf die Nutzerakzeptanz eingegangen been developed. At present, smart mobility still faces the challenge of generating greater user acceptance. As Whittle et al. showed in their 2019 analysis, user interests have not yet been sufficiently taken into account in the planning of smart mobility. Drivers' usage behavior must therefore change so that drivers in particular are willing to switch to different modes of transport. Confidence in the new smart mobility must increase and the range of services must improve in order to make the switch. Mulley and Kronsell also addressed this in their 2018 study. The necessary aspects that need to be taken into account for smart mobility include flexible and short-term availability, a competitive price, the same speed as by car and a service with easy access options. Service providers and mobility providers need to work more closely together. It is important that the offers are passed on to customers and users via many different providers so that users have a good chance of using many offers, which in turn increases speed and availability. The next mobility system must be developed in such a way that it appears attractive to the user (Kauschke, 2023).

In his analysis, Kauschke also comes to the conclusion that personal mobility behavior, modernity, experience with the new mobility and preferences for certain vehicle models as well as personal attitudes towards political interventions are decisive factors when it comes to electromobility. Understanding how autonomous systems can offer added value to society is particularly important for user interest in autonomous driving systems. This must be explained to customers. Furthermore, reliability, trust and confidence are the relevant components for the future reputation of automated mobility (Kauschke, 2023). In his study, Kauschke also comes to the conclusion that smart mobility is similar to mobility-as-a-service (MaaS). The advantages of location and time independence are particularly emphasized in modern systems.

In his study, Kauschke comes to the conclusion that smart mobility is less widely accepted by users than electromobility, but that acceptance is higher than for hydrogen vehicles. The respondents in this study consider smart mobility to be compatible with their lives, easy to use and efficient. Convenience, flexibility and safety are the main drivers for the performance rating. In Kauschke's 2023 study, however, only around 20% of respondents use smart mobility solutions more than once a week. However, a study by Fleury et al. from 2017 came to the conclusion that smart mobility is not perceived as something commonplace because it is expensive and socially unjust. Significantly more complex acceptance components can be derived from this. According to Kauschke's analysis, user acceptance depends on the factors of performance expectation, facilitating conditions, social influence, habit and hedonic motivation. Broader acceptance of smart mobility could therefore be achieved through the participation of users and citizens (Kauschke, 2023).

In weiteren Aspekten sollten auch die Ideen hinsichtlich of modern mobility hubs. These hubs can be central contact points for different modes of transport. Especially the changes in city centers with increasing vacancies could also be an approach for such modern transport hubs or parking centers (Hachette, L'Hostis, 2024). The increase in bicycles and other sustainable forms of mobility must also be taken into account in smart mobility approaches (Dylan, 2024).

In another study, Bellotti et al. come to the conclusion that smart mobility should also take into account the aspects of modern mobility platforms in order to have an optimal effect. Ecologically correct behaviour could be optimized through incentives or rewards from providers, service providers, authorities or insurance companies. Seamlessly expandable apps and ecosystems with suitable platforms could be the right approach here. Modern mobility systems therefore increasingly require a modern platform or their own ecosystem. The approach that collaborative mobility and smart mobility generally go hand in hand with ecologically positive mobility and therefore require a suitable ecosystem should be particularly emphasized here (Bellotti et al., 2016).

It is still questionable to what extent smart mobility should be implemented. However, further research into the literature has revealed various possibilities for use. This starts with the type of means of transportation, the combination of several people for one means of transportation, intelligent parking and traffic light control, sharing economy, sustainable drive ideas, etc. (Alba et al., 2016).

Back in 2013, Burkert came to the conclusion that the future of driving will be emission-free and connected. It is precisely this approach that this study takes up and essentially comes to the same conclusions. The combination of smart mobility and sustainability is primarily about leaving a minimal CO2 footprint in the scarce and precious space of city centers. However, Burkert also pointed out back in 2013 that the aim must be to create a form of mobility that is fully accepted by customers. The need for new mobility services and different vehicles will therefore continue to increase (Burkert, 2013).

It can therefore be seen that there is currently no specific study in the literature on the effects of the Green Deal on smart mobility. However, smart mobility is generally always associated with compensating for the disadvantages of existing forms of mobility and aims to achieve this through digital processes. Almost all studies also focus on the goal of sustainability as one of the main objectives of smart mobility.

3 Methodology and Data

The aim of the article is to use a systematic literature analysis and an online survey to work out the impact of the Green Deal on the field of smart mobility. This was answered in the form of closed questions in an online survey. A specific target group was not selected for the online survey. However, the participants were to be automotive customers or potential automotive customers and aged between 18 and 70. There were no people outside this age corridor in the survey. The primary interest of the work was to evaluate the interests and opinions of consumers in relation to the Green Deal and Smart Mobility. The questionnaire was initially structured with an indication that the survey was anonymous and that all relevant data protection regulations would be observed. The first two questions asked whether the respondents were aware of the contents of the Green Deal and Smart Mobility. On a subsequent information page, the respondents were given an explanation of what the Green Deal and Smart Mobility are, so that they had a uniform level of knowledge for the subsequent answers to the questions. Respondents were approached both in person and via online message. The survey was conducted in October and November 2023. For the analysis, mainly questions in the agreement range 1 (no agreement) to 5 (full agreement) were selected. The results are statistically analyzed below. Both linear and multiple linear regressions are carried out. The analysis was carried out using the statistics program R. To ensure reliable and valid data collection, the questionnaire followed a standardized pattern based on established scientific measurement instruments. Participants were randomly selected from a representative sample of (potential) automotive customers. Demographic characteristics such as age, gender and geographical location were also taken into account to ensure reasonable diversity within the respondents. The survey was conducted within the months of October and November 2023 to ensure that it was up to date.

The survey also complied with ethical standards. The participants were informed about the anonymity of the data, the voluntary nature and the purpose of the survey. This meant that there were no risks of data exposure and the data was stored in the empirio program used to conduct the survey.

There were no conflicts of interest, as the survey was conducted in an unbiased and impartial manner. This ensures the integrity and credibility of the results. The participants' data is respected and participants have the option of withdrawing from the survey at any time.

In order to enable a statistical analysis, the questions were structured as consent questions. The aforementioned research question is to be answered with the help of the following hypotheses. The following hypotheses result from the literature analysis carried out up to this point:

H1: The more familiar respondents are with the content of the Green Deal, the more familiar they are with the content of Smart Mobility.

H2: The more respondents are aware of the Green Deal, the more willing they are to use smart and sustainable mobility.

H3: The more respondents see the Green Deal as a measure to support environmental protection in sustainable mobility, the more likely they are to use multimodal mobility as part of smart mobility.

H4: The stronger perception of environmental goals or the Green Deal has a significant positive correlation with the more frequent choice of environmentally friendly means of transport.

H5: Stronger agreement with the objectives of the Green Deal correlates positively and significantly with preferences for sustainable mobility.

H6: The more likely respondents are to use conventional means of transport, the stronger the positive correlation with the expectation that car manufacturers will implement the Green Deal.

H7: A higher income correlates positively and significantly with a stronger preference for sustainable lifestyles and mobility solutions.

In the following chapter, the statistical evaluations of the hypotheses are carried out.

4 Results and discussion

Hypothesis 1 arose from the literature research and assumes that greater knowledge in the area of the Green Deal and environmental protection will also lead to greater interest in the field of smart mobility. It can therefore be assumed that the Green Deal generally has a positive effect on the development of smart mobility.

H1: ACCEPTANCE

```
Coefficients:
                        Estimate Std. Error t value Pr(>|t|)
(Intercept)              3.03861    0.15619  19.455  < 2e-16 ***
Agree1no5yesGDwellknown  0.27799    0.05765   4.822 3.08e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8392 on 174 degrees of freedom
Multiple R-squared:  0.1179,    Adjusted R-squared:  0.1128
F-statistic: 23.25 on 1 and 174 DF,  p-value: 3.082e-06
```

The P-value below 0.05 indicates that H1 can be assumed and that there is a correlation. The result makes it clear that there is a highly significant correlation between respondents' knowledge of the Green Deal and smart mobility. This also means that an increase in interest in the Green Deal leads to an increase in interest in and use of smart mobility. The multiple R-squared or the adjusted R-squared explains 11.79% of the variance of the dependent variables. It can therefore be concluded that only around 12% of the respondents' knowledge of smart mobility can be explained by their knowledge of the Green Deal. A 100% would be a perfect explanation.

Compared to hypothesis 1, hypothesis 2 assumes that an increase in knowledge about the Green Deal also leads to a higher use of smart mobility. This hypothesis must be rejected based on the available data, as the P value is over 17%. The model provides no explanatory contribution, so it can be assumed that there is no correlation.

H2: REJECTION

```
Coefficients:
                        Estimate Std. Error t value Pr(>|t|)
(Intercept)              3.50970    0.17306  20.280   <2e-16 ***
Agree1no5yesIoftenuseSM  0.07479    0.05485   1.364    0.174
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8888 on 174 degrees of freedom
Multiple R-squared:  0.01057,   Adjusted R-squared:  0.004886
F-statistic: 1.859 on 1 and 174 DF,  p-value: 0.1745
```

Hypothesis 3 assumes that the Green Deal actively contributes to environmental protection and that this is accompanied by a higher use of sustainable mobility. If respondents see the Green Deal as an opportunity for sustainable mobility, the more willing they are to use multimodal mobility, i.e. a combination of different mobility options.

H3: ACCEPTANCE

```
Coefficients:
                                   Estimate Std. Error t value Pr(>|t|)
(Intercept)                         1.47655    0.36781   4.014 8.84e-05 ***
Agree1no5yesGDpushessustainablemobility 0.51919    0.09878   5.256 4.28e-07 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.29 on 174 degrees of freedom
Multiple R-squared:  0.137,	Adjusted R-squared:  0.132
F-statistic: 27.62 on 1 and 174 DF,  p-value: 4.275e-07
```

The available data confirms the assumption of this hypothesis. According to this, a higher understanding of the Green Deal as an environmental protection option among respondents also leads to a higher acceptance of the use of multimodal mobility. The model delivers a highly significant result.

Hypothesis H4 showed that a higher perception of the environmental goals of the Green Deal also leads to a greater choice of sustainable means of transport. This finding emerged from existing studies as part of the literature review.

H4: ACCEPTANCE

```
Coefficients:
                                   Estimate Std. Error t value Pr(>|t|)
(Intercept)                         1.61514    0.33513   4.819 3.12e-06 ***
Agree1no5yesGDpushessustainablemobility 0.36034    0.09001   4.004 9.23e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.175 on 174 degrees of freedom
Multiple R-squared:  0.08435,	Adjusted R-squared:  0.07908
F-statistic: 16.03 on 1 and 174 DF,  p-value: 9.227e-05
```

The statistical analysis confirmed hypothesis 4 with a highly significant result.

Hypothesis 5 is based on a similar approach to hypothesis 4. Hypothesis 5 can also be confirmed in this context.

H5: ACCEPTANCE

```
Coefficients:
                                         Estimate Std. Error t value Pr(>|t|)
(Intercept)                               0.64088    0.21465   2.986  0.00324 **
Agree1no5yesSustainablelifestyleisimportantforme 0.78882    0.06336  12.450  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.8039 on 174 degrees of freedom
Multiple R-squared:  0.4711,	Adjusted R-squared:  0.4681
F-statistic:   155 on 1 and 174 DF,  p-value: < 2.2e-16
```

The result for hypothesis 5 is also highly significant.

Hypothesis 6 assumes a somewhat inverse relationship. It can be assumed that if customers make greater use of conventional and generally more environmentally harmful means of transport such as cars, they will expect customers to see car manufacturers as having a duty to meet the requirements of the Green Deal.

H6: ACCEPTANCE

```
Coefficients:
                          Estimate Std. Error t value Pr(>|t|)
(Intercept)                4.39071    0.34702   12.65   <2e-16 ***
Agree1no5yesImostlyusecar -0.19660    0.08226   -2.39   0.0179 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.218 on 174 degrees of freedom
Multiple R-squared:  0.03178,	Adjusted R-squared:  0.02622
F-statistic: 5.712 on 1 and 174 DF,  p-value: 0.01792
```

Hypothesis 6 can be confirmed, although the result is not high, but only significant.

Hypothesis 7 most recently referred to income and assumed that a higher income also correlates with a greater interest in sustainability, environmental protection and sustainable mobility. This cannot be confirmed in the survey, as the P value is significantly higher than 0.05.

H7: REJECTION

```
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.332e+00  1.171e-01  28.460   <2e-16 ***
income      -3.006e-05  3.362e-05  -0.894    0.372
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.9597 on 174 degrees of freedom
Multiple R-squared:  0.004575,	Adjusted R-squared:  -0.001146
F-statistic: 0.7997 on 1 and 174 DF,  p-value: 0.3724
```

The model does not provide an explanation for the hypothesis.

The individual study models all have relatively low coefficients of determination R-squared. The goodness of fit of the regression is therefore predominantly relatively low, which means that the proven correlations exist, but that other independent variables are responsible for explaining the dependent variable in the individual hypotheses.

This study provides a comprehensive insight into the link between the Green Deal and smart mobility. However, despite clear conclusions and identified links, there are several critical aspects that should be considered.

Firstly, the low awareness of the Green Deal among only about a quarter of respondents shows that public education and communication of this policy instrument is insufficient. This raises questions about the effectiveness of environmental protection measures if the population is not sufficiently informed. A more in-depth analysis of the educational levels and demographic characteristics of the uninformed could provide additional insights.

Secondly, the survey results reveal that despite some knowledge of the Green Deal, the willingness to use smart mobility is not necessarily increasing. This raises the question of whether the policy objectives of the Green Deal are sufficiently aligned with the individual needs and preferences of the population. A detailed analysis of the heterogeneity of response patterns could identify possible segments that need specific incentives.

Thirdly, the results emphasize the continued dominance of the car as the main mode of transport, despite increasing environmental awareness. This raises the question of the actual barriers to wider adoption of sustainable mobility solutions. A closer examination of the perceived barriers could help to develop more practical solutions.

Finally, the emphasis on multimodal mobility networks and the need to collaborate across sectors points to potential complexities and conflicts of interest. A critical analysis of the interests of the stakeholders involved, particularly the automotive industry, could reveal whether their motivation is in line with the environmentally friendly goals of the Green Deal or is based more on self-interest.

Overall, the study provides important insights, but emphasizes the need for in-depth critical reflection in order to ensure the sustainable implementation of the Green Deal in the field of smart mobility.

5 Conclusion

Overall, the study comes to clear and comprehensive conclusions. The impact of the Green Deal on intelligent, smart mobility is definitive. It is clear that the Green Deal and smart mobility are closely linked and have a certain interdependence. The Green Deal will probably not be feasible without the smart mobility approaches. The findings of the literature research have also shown that smart mobility goes far beyond the approaches of intelligent mobility and is often linked to the idea of sustainability.

Furthermore, the Green Deal approaches cannot simply be replaced by electromobility. Rather, a comprehensive, interlocking multimodal mobility network is needed for the future.

From a smart mobility perspective, it can be assumed that the Green Deal will continue to have a strong influence on smart mobility factors. This includes the promotion of sustainable mobility, technical innovations and a multimodal mobility concept. At the same time, the Green Deal will also change the fundamental environmental understanding of mobility. Regulatory standards have already been raised by politicians and, as already agreed, will continue to rise as part of the Green Deal. The automotive industry must therefore implement the Green Deal through smart mobility approaches.

The results of the survey also show a clear picture, although there is still room for future research in some areas. Overall, the survey results come to the conclusion that it will definitely be necessary to educate the population even more about the Green Deal and the aspects of environmental protection. In the survey, only around ¼ of respondents stated that they were aware of the content of the Green Deal. From the perspective of the survey, it can therefore currently be assumed that the Green Deal is more of a political issue that has not yet been fully understood and communicated by the population. However, even knowledge of the Green Deal does not lead to direct use of smart mobility. This study comes to the conclusion that it is necessary to communicate the contents of the Green Deal even better so that customers better understand the advantages of the Green Deal and the ideas for environmental protection. However, realistic implementation will only be possible if sensible multimodal mobility concepts are also implemented. The Green Deal must be understood as an opportunity to protect the environment. In addition, there must be a stronger commitment to the goals of environmental protection and the Green Deal so that customers are also prepared to make their mobility sustainable. Around 86% of respondents also stated that they still predominantly use the car as a means of transportation. However, the analysis also confirmed that it is precisely these customers who expect car manufacturers to implement the Green Deal. This results in a great responsibility for car manufacturers in particular. However, the findings from the literature research have also made it clear that a pure shift to electromobility is not the absolute approach. From the perspective of this thesis, it will be much more necessary for companies from various sectors, including airplane providers, rail companies, regional transport companies and new mobility providers such as scooter providers, to join forces with car manufacturers in order to develop joint ecosystems and software platforms to create a multimodal transport system that combines the advantages of all mobility systems. Above all, customers need a simple solution. Approaches here could include longer distances by train and the last mile with self-driving cars, rental cars or car-sharing vehicles. It is also relevant to note that the literature research has shown that people with higher incomes in particular are more likely to be able to afford sustainable solutions, as these are often still expensive. However, the study comes to the conclusion that interest in sustainable mobility solutions does not increase as income rises. It would therefore be even more important to develop cheaper, more sustainable solutions.

There is therefore no question that the Green Deal is having an impact. Customers understand the Green Deal and also see the connection with sustainable and smart mobility. However, there are currently still too few customers. Above all, it will be necessary to further intensify the understanding of the Green Deal and sustainable mobility and to offer solutions for all income levels across all forms of mobility. Car manufacturers in particular have a duty to do this. Simply switching to electromobility will not be the only solution and will not fulfill the aspects of smart mobility under the aspect of the Green Deal.

Literature:

1. Alba, E., Chicano, F. and Luque, G. (eds) (2016) *Smart Cities: First International Conference, Smart-CT 2016, Málaga, Spain, June 15-17, 2016, Proceedings*. Cham: Springer International Publishing (Lecture Notes in Computer Science). Available at: https://doi.org/10.1007/978-3-319-39595-1.

2. Baumann, S. and Püschner, M. (2017a) 'Smart Mobility Usage Scenarios I', in B. Flügge (ed.) *Smart Mobility – Connecting Everyone*. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 105–112. Available at: https://doi.org/ 10.1007/978-3-658-15622-0_7.

3. Baumann, S. and Püschner, M. (2017b) 'Smart Mobility Usage Scenarios I', in B. Flügge (ed.) *Smart Mobility – Connecting Everyone*. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 105–112. Available at: https://doi.org/1 0.1007/978-3-658-15622-0_7.

4. Bellotti, F. *et al.* (2016) 'A Smart Mobility Serious Game Concept and Business Development Study', in A. De Gloria and R. Veltkamp (eds) *Games and Learning Alliance*. Cham: Springer International Publishing (Lecture Notes in Computer Science), pp. 385–392. Available at: https://doi.org/10.1007/978-3-319-40216-1_43.

5. Böhm, F. *et al.* (2020) 'Toolbox for Analysis and Evaluation of Low-Emission Urban Mobility', in H. Krömker (ed.) *HCI in Mobility, Transport, and Automotive Systems. Driving Behavior, Urban and Smart Mobility*. Cham: Springer International Publishing (Lecture Notes in Computer Science), pp. 145–160. Available at: https://doi.org/10.1007/978-3-030-50537-0_12.

6. Broch, F., Warsen, J. and Krinke, S. (2015) 'Implementing Life Cycle Engineering in Automotive Development as a Helpful Management Tool to Support Design for Environment', in G. Sonnemann and M. Margni (eds) *Life Cycle Management*. Dordrecht: Springer Netherlands (LCA Compendium – The Complete World of Life Cycle Assessment). Available at: https://doi.org/10.1007/978-94-017-7221-1.

7. Burkert, A. (2013) 'Zweckorientiertes Design für Elektroautos', *ATZ extra*, 3.

Chouaibi, S. *et al.* (2022) 'The risky impact of digital transformation on organizational performance – evidence from Tunisia', *Technological Forecasting and Social Change*, 178, p. 121571. Available at: https://doi.org/10.1016/j.techfore.2022. 121571.

8. Claeys, G., Tagliapietra, S. and Zachmann, G. (2019) 'How to make the European Green Deal work', (13).

Dylan, M. (2024) 'A Systematic Literature Review on Station Area Integrating Micromobility in Europe: A Twenty-First Century Transit-Oriented Development', in F. Belaïd and A. Arora (eds) *Smart Cities*. Cham: Springer International Publishing (Studies in Energy, Resource and Environmental Economics), pp. 171–204. Available at: https://doi.org/10.1007 /978-3-031-35664-3_12.

9. Flügge, B. (2017a) 'Introduction', in B. Flügge (ed.) *Smart Mobility – Connecting Everyone*. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 1–3. Available at: https://doi.org/10.1007/978-3-658-15622-0_1.

10. Flügge, B. (2017b) 'Reflecting the Status Quo', in B. Flügge (ed.) *Smart Mobility – Connecting Everyone*. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 7–45. Available at: https://doi.org/10.1007/978-3-658-15622-0_2.

11. Flügge, B. (2017c) 'Smart Mobility Usage Scenarios II', in B. Flügge (ed.) *Smart Mobility – Connecting Everyone*. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 113–145. Available at: https://doi.org/10.1007/978-3-658-15622-0_8.

12. Flügge, B. (2017d) 'The Smart Mobility Ecosystem', in B. Flügge (ed.) *Smart Mobility – Connecting Everyone*. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 75–95. Available at: https://doi.org/10.1007/978-3-658-15622-0_5.

13. Flügge, B. (2020) 'Einführung', in B. Flügge (ed.) *Smart Mobility*. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 1–6. Available at: https://doi.org/10.1007/978-3-658-26980-7_1.

14. Galindo-Martín, M.-Á., Castaño-Martínez, M.-S. and Méndez-Picazo, M.-T. (2019) 'Digital transformation, digital dividends and entrepreneurship: A quantitative analysis', *Journal of Business Research*, 101, pp. 522–527. Available at: https://doi.org/10.1016/j.jbusres.2018.12.014.

15. Gidebo, F.A. and Szpytko, J. (2020) 'Transport System Telematics for Smart Cities Concept - A Case of Addis Smart Mobility Project', in J. Mikulski (ed.) *Research and the Future of Telematics*. Cham: Springer International Publishing (Communications in Computer and Information Science), pp. 17–26. Available at: https://doi.org/10.1007/978-3-030-59270-7_2.
16. Haas, T. and Sander, H. (2020) 'Decarbonizing Transport in the European Union: Emission Performance Standards and the Perspectives for a European Green Deal', *Sustainability*, 12(20), p. 8381. Available at: https://doi.org/10.3390/su12208381.
17. Hachette, M. and L'Hostis, A. (2024) 'Mobility Hubs, an Innovative Concept for Sustainable Urban Mobility?: State of the Art and Guidelines from European Experiences', in F. Belaïd and A. Arora (eds) *Smart Cities*. Cham: Springer International Publishing (Studies in Energy, Resource and Environmental Economics), pp. 245–278. Available at: https://doi.org/10.1007/978-3-031-35664-3_14.
18. Karlsson, I.C.M. (2020) 'Mobility-as-a-Service: Tentative on Users, Use and Effects', in H. Krömker (ed.) *HCI in Mobility, Transport, and Automotive Systems. Driving Behavior, Urban and Smart Mobility*. Cham: Springer International Publishing (Lecture Notes in Computer Science), pp. 228–237. Available at: https://doi.org/10.1007/978-3-030-50537-0_17.
19. Kauschke, L. (2023) *The Transition to Smart Mobility: Acceptance and Roles in Future Transportation*. Wiesbaden: Springer Fachmedien Wiesbaden. Available at: https://doi.org/10.1007/978-3-658-43001-6.
20. Khashoggi, A. and Mohammed, M.F.M. (2023) 'Smart Mobility in Smart City: A Critical Review of the Emergence of the Concept. Focus on Saudi Arabia', in A. Visvizi, O. Troisi, and M. Grimaldi (eds) *Research and Innovation Forum 2022*. Cham: Springer International Publishing (Springer Proceedings in Complexity), pp. 233–241. Available at: https://doi.org/10.1007/978-3-031-19560-0_18.
21. Konewka, T. and Czuba, T. (2022) 'An overview of some challenges of the electric vehicle industry in the light of the European Green Deal', in *Prawo I Klimat*, pp. 79–92.
Kucera, J. and Ticha, S. (2021) 'Czech Automotive Industry and COVID-19', *AD ALTA: Journal of Interdisciplinary Research*, 12(1), pp. 225–228.
22. Lee, C.-H. *et al.* (2021) 'Understanding digital transformation in advanced manufacturing and engineering: A bibliometric analysis, topic modeling and research trend discovery', *Advanced Engineering Informatics*, 50, p. 101428. Available at: https://doi.org/10.1016/j.aei.2021.101428.
23. Li, H. *et al.* (2021) 'Organizational mindfulness towards digital transformation as a prerequisite of information processing capability to achieve market agility', *Journal of Business Research*, 122, pp. 700–712. Available at: https://doi.org/10.1016/j.jbusres.2019.10.036.
24. Li, H. and Yang, C. (2021) 'Digital Transformation of Manufacturing Enterprises', *Procedia Computer Science*, 187, pp. 24–29. Available at: https://doi.org/10.1016/j.procs.2021.04.029.
25. Löschel, A. (2020) 'European Green Deal und deutsche Energiewende zusammen denken!', *Wirtschaftsdienst*, 100(2), pp. 78–79. Available at: https://doi.org/10.1007/s10273-020-2566-x.
26. Molnár, P., Suta, A. and Tóth, Á. (2023) 'Sustainability accounting for greenhouse gas emissions measurement using the GREET LCA model: practical review of automotive ESG reporting', *Clean Technologies and Environmental Policy* [Preprint]. Available at: https://doi.org/10.1007/s10098-023-02588-y.
27. Nienaber, A.-M. *et al.* (2020) 'Employees' Vulnerability – The Challenge When Introducing New Technologies in Local Authorities', in H. Krömker (ed.) *HCI in Mobility, Transport, and Automotive Systems. Driving Behavior, Urban and Smart Mobility*. Cham: Springer International Publishing (Lecture Notes in Computer Science), pp. 297–307. Available at: https://doi.org/10.1007/978-3-030-50537-0_22.
28. Omahne, V., Knez, M. and Obrecht, M. (2021) 'Social Aspects of Electric Vehicles Research—Trends and Relations to Sustainable Development Goals', *World Electric Vehicle Journal*, 12(1), p. 15. Available at: https://doi.org/10.3390/wevj12010015.
29. Orecchini, F. *et al.* (2019) 'Blockchain Technology in Smart City: A New Opportunity for Smart Environment and Smart Mobility', in P. Vasant, I. Zelinka, and G.-W. Weber (eds) *Intelligent Computing & Optimization*. Cham: Springer International Publishing (Advances in Intelligent Systems and Computing), pp. 346–354. Available at: https://doi.org/10.1007/978-3-030-00979-3_36.
30. Peyravi, B., Peleckienė, V. and Vaičiūtė, K. (2022) 'Research on the Impact of Motorization Rate and Technological Development on Climate Change in Lithuania in the Context of the European Green Deal', *Sustainability*, 14(18), p. 11610. Available at: https://doi.org/10.3390/su141811610.
31. Rafieefar, M. (2022) *The Paradox of Green Development: A Critical Discourse Analysis of the European Green Deal with a Specific Focus on Electric Vehicles*.
Reichenbach, M. (2020) 'The Real Green Deal', *ATZ worldwide*, 11/2020, p. 3.
32. Rukanova, B. *et al.* (2023) 'A Framework for Understanding Circular Economy Monitoring: Insights from the Automotive Industry', in *Proceedings of the 24th Annual International Conference on Digital Government Research. DGO 2023: Digital government and solidarity*, Gda?sk Poland: ACM, pp. 544–555. Available at: https://doi.org/10.1145/3598469.3598530.
33. Schönmayr, D. (2017) 'Automotive Plastics and Sustainability', in Schönmayr, D., *Automotive Recycling, Plastics, and Sustainability*. Cham: Springer International Publishing, pp. 29–77. Available at: https://doi.org/10.1007/978-3-319-57400-4_3.
34. Semmens, J., Bras, B. and Guldberg, T. (2014) 'Vehicle manufacturing water use and consumption: an analysis based on data in automotive manufacturers' sustainability reports', *The International Journal of Life Cycle Assessment*, 19(1), pp. 246–256. Available at: https://doi.org/10.1007/s11367-013-0612-2.
35. Sikora, A. (2021) 'European Green Deal – legal and financial challenges of the climate change', *ERA Forum*, 21(4), pp. 681–697. Available at: https://doi.org/10.1007/s12027-020-00637-3.
36. Singh, S., Sharma, M. and Dhir, S. (2021) 'Modeling the effects of digital transformation in Indian manufacturing industry', *Technology in Society*, 67, p. 101763. Available at: https://doi.org/10.1016/j.techsoc.2021.101763.
37. Thormann, L., Neuling, U. and Kaltschmitt, M. (2023) 'Opportunities and challenges of the European Green Deal for the chemical industry: An approach measuring circularity', *Cleaner and Circular Bioeconomy*, 5, p. 100044. Available at: https://doi.org/10.1016/j.clcb.2023.100044.
38. Traverso, M. *et al.* (2015) 'Managing Life Cycle Sustainability Aspects in the Automotive Industry', in G. Sonnemann and M. Margni (eds) *Life Cycle Management*. Dordrecht: Springer Netherlands (LCA Compendium – The Complete World of Life Cycle Assessment). Available at: https://doi.org/10.1007/978-94-017-7221-1.
39. Troise, C. *et al.* (2022) 'How can SMEs successfully navigate VUCA environment: The role of agility in the digital transformation era', *Technological Forecasting and Social Change*, 174, p. 121227. Available at: https://doi.org/10.1016/j.techfore.2021.121227.
40. Vinodh, S. and Jayakrishna, K. (2013) 'Assessment of product sustainability and the associated risk/benefits for an automotive organisation', *The International Journal of Advanced Manufacturing Technology*, 66(5–8), pp. 733–740. Available at: https://doi.org/10.1007/s00170-012-4361-3.
41. Vogel, H.-J., Weißer, K. and Hartmann, W. (2018) 'Smart Mobility Neu Denken', in Vogel, H.-J., Weißer, K., and D.Hartmann, W., *Smart City: Digitalisierung in Stadt und Land*. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 28–32. Available at: https://doi.org/10.1007/978-3-658-19046-0_4.
42. Wellbrock, W. *et al.* (2020) 'Sustainability in the automotive industry, importance of and impact on automobile interior – insights from an empirical survey', *International Journal of Corporate Social Responsibility*, 5(1), p. 10. Available at: https://doi.org/10.1186/s40991-020-00057-z.
43. Wendt, J. *et al.* (2023) 'Approach for Design of Low Carbon Footprint Paint Shops in the Automotive Industry', in H. Kohl,

G. Seliger, and F. Dietrich (eds) *Manufacturing Driving Circular Economy*. Cham: Springer International Publishing (Lecture Notes in Mechanical Engineering), pp. 490–498. Available at: https://doi.org/10.1007/978-3-031-28839-5_55.

44. Wyns, T. and Khandekar, G. (2019) 'Industrial Climate Neutrality in the EU: Outline of an Integrated Industrial Green Deal', *Intereconomics*, 54(6), pp. 325–332. Available at: https://doi.org/10.1007/s10272-019-0848-6.

45. Yi, Y. *et al.* (2023) 'Fuel consumption and carbon emission reduction strategies in a fuel vehicle supply chain under auto double credit policy and carbon social responsibility', *Environment, Development and Sustainability* [Preprint]. Available at: https://doi.org/10.1007/s10668-023-03887-6.

46. Zengin, F. *et al.* (2022) 'Applications and Expectations of Fuel Cells and Lithium Ion Batteries', in N.M. Durakbasa and M.G. Gençyılmaz (eds) *Digitizing production systems: selected papers from ISPR2021, October 07-09, 2021 Online, Turkey. International Symposium for Production Research*, Cham: Springer (Lecture notes in mechanical engineering), pp. 91–106.

Primary Paper Section: A

Secondary Paper Section: AE, AH