PROBLEMY EKOROZWOJU/ PROBLEMS OF SUSTAINABLE DEVELOPMENT

SUBMITTED: 28.10.2025, ACCEPTED: 27.11.2025, PUBLISHED ON-LINE: 10.01.2026
2026, 21(1): 326-341, DOI: 10.35784/preko.8646

Prospects for Development of the Global Automotive Industry in Context of Digitalization and Achievement of the Sustainable Development Goals

Perspektywy rozwoju globalnego przemysłu motoryzacyjnego w kontekście cyfryzacji i realizacji Celów Zrównoważonego Rozwoju

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Abstract

Since 2007, the global economy has been in a state of instability. National governments are searching for methods to stimulate the development of their economies and individual industries that can become drivers pulling their countries forward. An increasing number of researchers agree that the automotive industry can become such a locomotive. The purpose of this article is to provide theoretical justification and identify prospects for the development of the global automotive industry in the context of digitalization, taking into account the priorities of achieving the Sustainable Development Goals (SDGs). Transformational processes in the global automotive industry are examined through the prism of achieving the UN Sustainable Development Goals. Based on the analysis of statistical data for 2014–2024, it has been established that the share of the automotive industry in global GDP averages 3-5%, and taking into account related industries – up to 7-8%. The study shows that China maintains its leadership, accounting for over 33% of global car production, while South Korea has one of the highest shares of the industry in GDP – 10-12%, and the United States and Germany demonstrate stable growth due to investments in electric vehicles. The use of the exponential smoothing method for forecasting the profitability of leading companies revealed that by 2028, Tesla's profit may increase from 14 to 29.5 billion USD, Apple's – from 93.7 to 125.8 billion USD, and Xiaomi's – from 9.1 to 8.9 billion USD with a tendency toward gradual recovery. The results confirm that digitalization, electrification of transport, the implementation of artificial intelligence, and environmentally friendly technologies form a new paradigm of automotive industry development focused on energy efficiency, safety, and climate neutrality. It is shown that digitalization acts as a catalyst for sustainable trans-

formation in the global automotive industry, enhancing competitiveness, environmental safety, and the socio-economic resilience of society. The integration of the automotive and technology sectors contributes to the achievement of SDGs 7, 9, 11, 12, and 13, ensuring the transition to a *green* economy and a sustainable urban environment. The automotive industry is identified as a strategic factor of global economic stability and innovative growth, capable of ensuring a balanced combination of economic, environmental, and social priorities of sustainable development.

Key words: sustainable development goals, economic resilience, automotive industry, green economy, ecology, digital technologies, digitalization, competition, strategy, globalization, innovation, market, finance, international economics

Streszczenie

Od 2007 roku globalna gospodarka znajduje się w stanie niestabilności. Rządy państw poszukują metod stymulowania rozwoju swoich gospodarek i poszczególnych branż, które mogą stać się motorami napędowymi dla rozwoju ich krajów. Coraz więcej badaczy zgadza się, że przemysł motoryzacyjny może stać się taką lokomotywą. Celem niniejszego artykułu jest przedstawienie uzasadnienia teoretycznego i wskazanie perspektyw rozwoju globalnego przemysłu motoryzacyjnego w kontekście cyfryzacji, z uwzględnieniem priorytetów realizacji Celów Zrównoważonego Rozwoju (SDGs). Procesy transformacyjne w globalnym przemyśle motoryzacyjnym analizowane są przez pryzmat realizacji Celów Zrównoważonego Rozwoju ONZ. Na podstawie analizy danych statystycznych za lata 2014–2024 ustalono, że udział przemysłu motoryzacyjnego w globalnym PKB wynosi średnio 3–5%, a z uwzględnieniem branż pokrewnych – nawet 7–8%. Badanie pokazuje, że Chiny utrzymują pozycję lidera, odpowiadając za ponad 33% światowej produkcji samochodów, Korea Południowa ma jeden z najwyższych udziałów branży w PKB – 10-12%, a Stany Zjednoczone i Niemcy wykazują stabilny wzrost dzięki inwestycjom w pojazdy elektryczne. Zastosowanie metody wygładzania wykładniczego do prognozowania rentowności wiodących firm wykazało, że do 2028 roku zysk Tesli może wzrosnąć z 14 do 29,5 mld USD, Apple – z 93,7 do 125,8 mld USD, a Xiaomi – z 9,1 do 8,9 mld USD, z tendencją do stopniowego wzrostu. Wyniki potwierdzają, że digitalizacja, elektryfikacja transportu, wdrażanie sztucznej inteligencji i technologie przyjazne dla środowiska tworzą nowy paradygmat rozwoju przemysłu motoryzacyjnego skoncentrowany na efektywności energetycznej, bezpieczeństwie i neutralności klimatycznej. Wykazano, że digitalizacja działa jako katalizator zrównoważonej transformacji w globalnym przemyśle motoryzacyjnym, zwiększając konkurencyjność, bezpieczeństwo środowiskowe i odporność społeczno-ekonomiczną społeczeństwa. Integracja sektora motoryzacyjnego i technologicznego przyczynia się do osiągnięcia Celów Zrównoważonego Rozwoju nr 7, 9, 11, 12 i 13, zapewniając przejście na *zieloną* gospodarkę i zrównoważone środowisko miejskie. Przemysł motoryzacyjny jest uznawany za strategiczny czynnik globalnej stabilności gospodarczej i innowacyjnego wzrostu, zdolny do zapewnienia zrównoważonego połączenia ekonomicznych, środowiskowych i społecznych priorytetów zrównoważonego rozwoju.

Słowa kluczowe: cele zrównoważonego rozwoju, resilencja gospodarcza, przemysł motoryzacyjny, zielona gospodarka, ekologia, technologie cyfrowe, cyfryzacja, konkurencja, strategia, globalizacja, innowacja, rynek, finanse, gospodarka międzynarodowa

1. Introduction

The modern stage of global automotive industry development is characterized by profound transformations driven by digitalization, global competition, and increasing environmental requirements. The automotive industry, being one of the key sectors of the world economy, simultaneously remains one of the largest sources of carbon emissions, energy consumption, and material resource use. In this context, there is an urgent need to reorient the strategic priorities of industry development in accordance with the United Nations Sustainable Development Goals (SDGs), which define the global benchmarks for humanity's social, economic, and environmental progress up to 2030.

Achieving the Sustainable Development Goals in the automotive industry is possible through the implementation of several interrelated directions. Firstly, within Goal 7 Affordable and Clean Energy, there is an active transition toward the use of electric vehicles, hydrogen technologies, and renewable energy sources, which reduces dependence on fossil fuels and decreases harmful emissions. Goal 9 Industry, Innovation, and Infrastructure is being realized through the implementation of the concepts of *Industry 4.0*, smart manufacturing, the Internet of Things, artificial intelligence, and autonomous transport. These technologies contribute to the formation of an innovative automotive ecosystem and enhance its global competitiveness.

In the context of Goal 11 Sustainable Cities and Communities, the development of smart mobility gains particular importance – including electric vehicle networks, car-sharing systems, and the integration of transport into *smart city* systems. This helps reduce air pollution, noise levels, and traffic congestion in large urban areas. The implementation of Goal 12 Responsible Consumption and Production involves introducing circular models of resource

use, recycling of components and batteries, and reducing energy consumption and waste throughout the entire vehicle life cycle.

The automotive industry also plays a significant role in achieving Goal 13 Climate Action, since transport decarbonization is one of the most effective tools for reducing global greenhouse gas emissions. Moreover, the development of the *green* industry contributes to the implementation of Goal 8 Decent Work and Economic Growth by creating new jobs in high-tech sectors, stimulating investment and innovation. Indirectly, the automotive industry supports Goal 3 Good Health and Well-being by lowering environmental pollution levels, and Goal 17 Partnerships for the Goals through international cooperation among governments, corporations, and scientific institutions.

In recent decades, the global economy has been in a state of turbulence and uncertainty, while national economies continue searching for models of sustainable development and drivers of growth and economic security. Experts from various scientific fields focus their efforts on solving these issues. Humanity consistently draws attention to these global challenges in its pursuit of sustainable and long-term development of economic systems, once again emphasizing the importance of the automotive industry — both as a key sector of any national economy and as a crucial component of the global economic system.

To support the above, we will analyze the trends in changes in the share of the automotive industry in the gross domestic product of developed countries and the global economy. Unfortunately, there is no unified global open-access statistic on the share of the automotive industry in world GDP. However, separate studies by the International Organization of Motor Vehicle Manufacturers (OICA, 2025; World Bank, 2025) the (OECD, 2025) national industry agencies, and consulting firms such as (McKinsey, 2025) (PwC, 2025) and (Statista, 2025) provide estimates of the automotive industry's contribution to the global economy. Therefore, to compile an analytical table, we consolidate these indicators and analyze them comparatively (table 1).

Table 1. Share of the automotive industry in the GDP of developed countries (%), 2014-2024, source: compiled by the authors (World Bank; JAMA; McKinsey & Company; OICA)

Year	USA	China	Germany	Japan	South Korea	India	World GDP
2014	3.1	7.2	4.9	5.3	11.8	7.0	3.8
2015	3.2	7.4	4.8	5.1	11.5	6.9	3.9
2016	3.1	7.3	4.7	5.0	11.2	6.7	4.0
2017	3.0	7.2	4.6	5.0	11.0	6.6	4.1
2018	2.9	7.0	4.6	4.9	10.8	6.5	4.2
2019	2.8	6.8	4.5	4.8	10.5	6.3	4.0
2020	2.3	6.1	3.8	4.2	9.5	5.7	3.5
2021	2.6	6.4	4.1	4.5	10.0	6.0	3.7
2022	2.5	6.2	4.0	4.4	9.8	5.8	3.8
2023	3.0	9.0	4.9	4.7	12.0	7.1	3.9
2024	3.1	9.2	5.0	4.8	12.2	7.5	4.0

Based on the data presented above (table 1), it can be stated that even under post-industrial development conditions, the world's key economies recognize the importance of the automotive industry in ensuring sustainable economic growth and pay significant attention to this sector.

From the obtained data, the following trends can be identified:

- China remains the global leader in automobile production and exports, and its share in GDP continues to grow due to the national program supporting electrification and the boom in electric vehicles, both in domestic and global markets.
- Germany maintains a high level of automotive industry development, although electrification and global competition exert pressure on its positions.
- South Korea has one of the largest shares of the automotive industry in GDP structure (10-12%) thanks to some of the most advanced manufacturers (Hyundai, Kia). This sector is strategic for the national economy, with vehicle sales accounting for about 10% of the country's total exports.
- The United States is gradually increasing its share due to investments in electric vehicles (Tesla, GM, Ford), but the level remains lower than that of the EU and Asian countries.
- Japan – the automotive sector generates around 15% of export revenues, and tax contributions from companies such as Toyota, Honda, and Nissan are a key source of government revenue. However, the industry's share in GDP shows a downward trend due to outsourcing of production abroad, particularly to China, Thailand, and Mexico.
- India is rapidly growing as a global automotive manufacturing hub thanks to low production costs and active export programs.

On a global scale, the automotive industry traditionally accounts for 3–5% of world GDP, and if related industries such as metallurgy, chemistry, IT services, transportation, and vehicle maintenance are included, the contribution increases to 7-8% of global GDP. The spread of vehicle electrification shifts the focus within the industry, leading

to increased investment in the development and production of batteries, electronics, and software, fundamentally transforming the sector's structure.
Thus, the development of the global automotive industry in the era of digitalization has become an important factor in implementing the principles of sustainable development. Modern technological, energy, and environmental innovations form the foundation for the transition of the industry from traditional models of mass resource consumption to a *green* innovation economy, oriented toward long-term ecological balance, economic efficiency, and social responsibility.

2. Literature review

Modern global economic trends compel specialists to increasingly focus on the real sectors of the economy, identifying strategic industries among them and forecasting their development trends that can become the locomotive of long-term and stable economic growth of national economic systems and the achievement of the Sustainable Development Goals (SDGs).
The issue of the global automotive industry's development under digitalization and the achievement of the Sustainable Development Goals has gained particular relevance in recent scientific research. Digital transformations, the implementation of intelligent technologies, transport electrification, changes in consumption models, and new environmental standards are forming a qualitatively new paradigm of automotive industry development directly linked to the realization of sustainable development principles.
Lopez-Vega et al. (2023), in their article Digital Transformation of the Automotive Industry, note that digitalization acts as a key factor of structural change in the global automotive sector. The authors identified over 20 areas of digital technologies (including the Internet of Things, big data, cloud services, and digital twins) that significantly affect production processes, innovation potential, and business models of automotive enterprises. They argue that digital tools become the foundation for improving energy efficiency, reducing emissions, and transitioning toward sustainable mobility.
In the study by Pérez-Moure et al. (2023) How Sustainable, Autonomous, and Connected Vehicles Are Changing Digital Mobility Business Models, it is emphasized that the combination of autonomy, electrification, and connectivity creates a new logic of business models in the transport industry. The authors analyze the practices of four leading car manufacturers (Tesla, Volkswagen, Toyota, BYD) and show that the integration of artificial intelligence, big data analytics, and shared mobility services provides competitive advantages and contributes to achieving SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities).
Avasilcăi, Gavriluță, and Popescu (2025), in their work Digital Technologies to Support Sustainable Consumption: An Overview of the Automotive Industry, reveal the role of digital technologies in shaping environmentally responsible consumer behavior. In particular, through the development of online platforms, monitoring systems, and digital ecosystems, automakers can ensure transparency throughout the product life cycle, increase material recycling rates, and promote conscious consumption. According to the authors, this directly supports SDG 12 (Responsible Consumption and Production).
Vijaya et al. (2025), in the publication Advancing Sustainability in the Automotive Sector: A Critical Analysis of Environmental, Social and Governance (ESG) Performance Indicators, applied the Fuzzy DEMATEL and Fuzzy TOPSIS methods to analyze ESG indicator systems in the automotive industry. The researchers found that digitalization is a catalyst for improving environmental management efficiency, corporate governance transparency, and social responsibility. In particular, implementing digital reporting tools allows companies to better align their activities with SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action).
In the study by Glova and Panko (2025), The Effects of Environmental, Social, and Governance Factors on Financial Performance and Market Valuation in the European Automotive Industry, a panel analysis of 60 European automotive companies over 2011–2022 was conducted. The authors proved that high social ESG scores positively affect profitability (ROA), while environmental investments may temporarily reduce financial results in the short term but increase capitalization in the long run. At the same time, the implementation of digital technologies serves as a mediator between environmental initiatives and financial performance.
Previous research has already emphasized the importance of automotive production in ensuring economic security and supporting national economic development (Kozlovskyi et al., 2019), demonstrating that vehicle electrification is a crucial factor of innovative economic growth and a key to sustainable development. However, the global automotive industry is currently undergoing another cyclical transition, and accurate forecasting of future trends can secure leadership in this market for both individual enterprises and entire economic systems.
Such ideas are quite popular in academic discourse. The automotive industry has been at the epicenter of every major industrial revolution, creating distinct innovative phases that have reshaped the essence of manufacturing itself. Initially a labor-intensive sector, it has gradually evolved through technological breakthroughs and industrialization of core processes into one of the most technology-sensitive industries (Dimitrakopoulos et al., 2021).

Yiyuan Wang argues that the automotive industry is experiencing a convergence of the physical and digital worlds, driving transformation and enabling greater efficiency and flexibility in production. This shift is expected to significantly influence the industry, with advantages including faster product development, improved quality, and reduced costs (Wang et al., 2023).
Considering its utilitarian nature, transport is often perceived merely as a logistical necessity, yet it possesses enormous transformative potential that is integral to both modern economies and individual daily life (Marra et al., 2020).
According to E. Mogaji, the automotive industry stands on the threshold of evolutionary transformations based on the transition from the logic of car ownership as an asset to the logic of shared value creation. This reflects broader social changes beyond mere industrial evolution and will have a strategic impact on the entire economic system – where ownership is no longer a priority, and services such as Uber and Mobility-as-a-Service (MaaS) thrive under this approach (Mogaji, 2025).
MacCarthy and Ivanov (2022) consider the automotive sector a critically important component of the global economy that is undergoing revolutionary change under the influence of digitalization and artificial intelligence implementation.
Based on all the above, it can be confidently stated that the automotive industry remains a critical sector influencing the development of economic systems at both regional and global levels. At the same time, it stands at the threshold of profound transformations capable of reshaping its structure and determining future directions of technological, socio-cultural, and societal evolution. Thus, leadership in technological and economic development will belong to those countries that timely recognize the trends in automotive industry transformation and provide stimulating conditions for domestic manufacturers to achieve the Sustainable Development Goals.
Summarizing the results of the review, it can be noted that modern scientific thought views digitalization as a central factor in the evolution of the automotive industry, combining innovative development with the achievement of the Sustainable Development Goals. Digital technologies increase production efficiency, reduce environmental impact, stimulate the development of the circular economy, and create the foundation for new models of sustainable consumption and mobility. Therefore, the synergy between digital transformation and sustainable development principles determines the strategic guidelines for the future of the global automotive industry.

3. The aim

The purpose of this article is to provide a theoretical justification and to identify the prospects for the development of the global automotive industry in the context of digitalization, taking into account the priorities of achieving the Sustainable Development Goals. The study involves an analysis of current trends in the transformation of the automotive sector, an assessment of the impact of innovative technologies on the environmental and energy efficiency of the industry, and the identification of strategic directions for the transition to a *green* and climate-neutral model of automotive production.

4. Methodology

To achieve the stated goal, the research process was carried out in several stages. Statistical data on the development of demand and supply in the global automobile market were collected; key national markets within the overall market structure were identified along with their significance and development trends, and relevant charts were constructed. To determine the impact and interrelation between the technology sector and the automotive industry, the leading companies in both sectors were identified based on their market capitalization, and an analysis of their main performance indicators was conducted.
The main prospective characteristics of a competitive automobile were defined, allowing the identification of potential market leaders – namely Tesla, Apple, and Xiaomi – whose current status was analyzed. A forecast of further development scenarios for these companies was then made using profit data for the past five years, applying the exponential smoothing method, which uses the following formula 1 (Chatterjee et al., 2013):

$$\bar{Y}t + 1 = k \cdot Yt + (1 - k) \cdot \bar{Y}t \quad (1)$$

where:
$\bar{Y}t + 1$ – forecast for the next period t+1;
Yt – actual value used for the forecast in the current period t (gross profit by year);
k – smoothing coefficient, 0<k<1;
$\bar{Y}t$ – forecasted value for the current period t.
In the first period (year), $\bar{Y}1 = Y1$, meaning that the forecast for the first period equals the actual profit in that period.
This method was chosen because it is most suitable for forecasting socio-economic processes. All calculations were entered into corresponding tables and supplemented with graphical representations, which facilitate visualization and improve the accuracy of conclusions.

5. Results

The integration of the automotive and technology sectors directly contributes to achieving Sustainable Development Goals 7, 9, 11, 12, and 13, as it forms the foundation for developing a new model of a *green* economy based on energy efficiency, innovation, and minimal environmental impact. The introduction of digital technologies into vehicle production and operation enables energy consumption optimization and the development of renewable energy sources (Goal 7), as well as enhances industrial innovation capacity through the use of artificial intelligence, IoT, big data, and automation (Goal 9).

In turn, the development of *smart* transportation, car sharing, and autonomous control systems helps reduce traffic congestion and air pollution in cities, thus contributing to Goal 11 – the creation of sustainable and safe urban spaces. The use of eco-friendly materials, circular production models, and component reuse supports Goal 12, while the reduction of CO_2 emissions and the shift toward climate-neutral technologies are directly linked to Goal 13 – climate action. Therefore, the interaction between the automotive and technology sectors is a key driver of sustainable development, combining environmental, economic, and social priorities of the global economy.

The COVID-19 pandemic had a significant impact on the dynamics of the global automotive market. According to OICA analysts, it was the worst crisis ever to affect the automotive industry. As a result of the global challenges faced by manufacturers, dealers, and suppliers, tectonic shifts occurred in the structure of the market, which are still being felt today and continue to shape the emerging concept of the car of the future. The effects of COVID-19 on the global automotive market can be summarized as follows:

1. Changes in the consumption structure. The pandemic led to an increase in demand for private mobility while simultaneously causing a decline in new car purchases by more than 15% in 2020 compared to 2019. Due to growing demand polarization, two parallel trends emerged: rising demand for electric vehicles and for used cars. The strengthening of remote sales models pushed demand toward digitalization and increased the popularity of smart products, including in the automotive sector. In quantitative terms, demand returned to pre-pandemic levels in 2023 and continues to grow gradually.
2. Changes in the production structure. Like demand, supply demonstrated a significant decline of approximately 16% (OICA, 2021). The depth of production decline varied across countries: some experienced steep drops, while others saw only slight decreases. According to Dow Jones, the combined revenue losses of the world's 19 largest automakers amounted to USD 246.2 billion (Dow Jones, 2020). The biggest losses were suffered by manufacturers of traditional internal combustion engine vehicles. For example, Toyota Motor Corp. and Volkswagen AG together lost USD 69.61 billion in the first half of 2020. However, the downturn did not affect all automakers: Tesla Inc. demonstrated the opposite trend, increasing its revenue by USD 1 billion during the same period. The recovery process continues to this day. Slow growth is associated with several factors. Due to the technological sector's pivot toward supplying electronic chips for consumer electronics—whose demand surged during the pandemic—the auto industry faced a semiconductor shortage in 2021–2022. Disruptions in supply chains forced automakers to invest in production localization, while tech companies began considering entering this new market.
3. A push toward electrification. Demand- and supply-side factors, as well as the inclusion of green priorities in post-COVID recovery programs, accelerated the electrification of vehicles worldwide. The rapid increase in the popularity of electrified transport across the globe can be clearly demonstrated by the statistical data presented in the table 2.

Table 2. Structure of the Global Market for New Passenger Car Sales by Engine Type, % for 2019–2024, source: compiled by the authors (Rho Motion 2025; Virta2025; IEA 2024)

Year / Engine type	2019	2020	2021	2022	2023	2024
BEV	2.5	4.6	8.3	13	16.5	22
PHEV	1	1.8	2.5	3.5	4	4.5
HEV	4.0	5.5	6.5	7.5	8.5	9.5
ICE	92.5	88.1	82.7	76	71	64

As seen from the table, the share of electric vehicles has increased almost tenfold over the past six years compared to the pre-COVID year 2019, while the share of internal combustion engine vehicles has declined by nearly one third in quantitative terms (Rho Motion, 2025). This situation is best illustrated in Fig. 1.

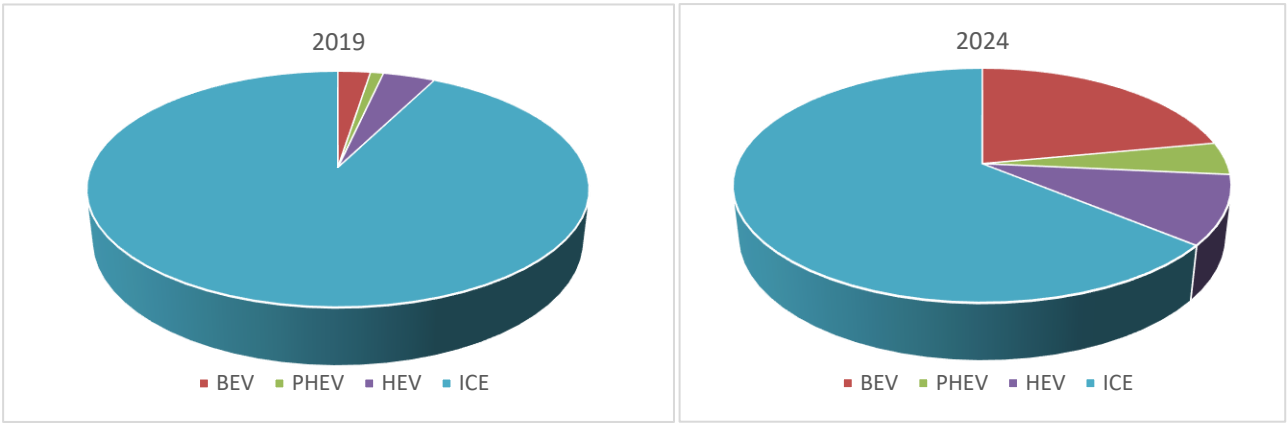

Figure 1. Structure of the Global Market of Newly Sold Vehicles in 2019 and 2024, source: compiled by the authors

Thus, we can assert that the COVID-19 pandemic became a catalyst for profound transformations in the automotive market. Its short-term effects are already observable, while in the long term these changes will lead to a strategic reshaping of the market, the emergence of new players, and a new philosophy regarding the design and use of vehicles.

To continue the study of potential development scenarios for the automotive industry, it is necessary to fix the current situation, identify market leaders, and analyze their development strategies.

According to Table 3, both automobile production and consumption in the global market have been growing over the past five years. Moreover, the number of cars purchased exceeded production volumes, with only minor shortfalls observed in 2022 and 2023. This situation is encouraging and indicates significant growth potential in the market.

Let us analyze the state of the global automotive industry, noting that despite the extensive experience of the United States and EU countries in automotive manufacturing, China is now justifiably considered one of the global leaders in vehicle production. For example, in 2020 China accounted for 32.5%, and by 2024 already 33.8% of global car production (see table 3).

At the same time, despite globalization, the Chinese automotive market remains specific and relatively autonomous due to its strong domestic demand. In 2020, car sales in China reached 36.4%, and in 2024 – 38.3% of the total number of cars sold worldwide. Such rapid growth in China's automotive sector is driven by government support programs, both in car manufacturing and purchasing, including the introduction of special free economic zones and favorable macroeconomic conditions.

Since 2000, China has recorded an annual 6% increase in employment in its mechanical engineering enterprises, while this figure has declined in developed countries – by 2% in the EU and 3% in Japan and the USA. This demonstrates a clear trend toward greater localization of production in Eastern countries, influenced largely by lower labor costs. For example, in 2022, the labor cost per employee in China's automotive industry was five times lower than in the EU, three times lower than in the USA, and twice lower than in Japan (Ishchuk et al., 2022).

Table 3. Volumes of automobile production and consumption in key industry countries, 2020-2024, source:*:* compiled by the authors (OICA, 2025)

Country | Year	2020		2021		2022		2023		2024	
	Consumption volume	Production volume	Consumption volume	Production volume	Consumption volume	Production volume	Consumption volume	Production volume	Consumption volume	Production volume
USA	14881356	8822399	15408565	9167214	14230324	10052958	16009268	10639140	16340472	10562188
CHINA	25311069	25225242	26314263	26082220	26863745	27020615	30093698	30160966	31436193	31281592
GERMANY	3266759	3742454	2973319	3308692	2963748	3480357	3204298	4109371	3192031	4069222
JAPAN	4598615	8067557	4448340	7846955	4201320	7835539	4779086	8998538	4421494	8234681
SOUTH KOREA	1905972	3506774	1734581	3462404	1683657	3757049	1749729	4243597	1632751	4127252
INDIA	2938575	3394446	3759398	4399112	4725840	5457242	5080361	5852143	5226784	6014691
TOTAL	79668636	77621582	83638420	80145989	82985782	84810719	92850054	93452506	95314730	92504338

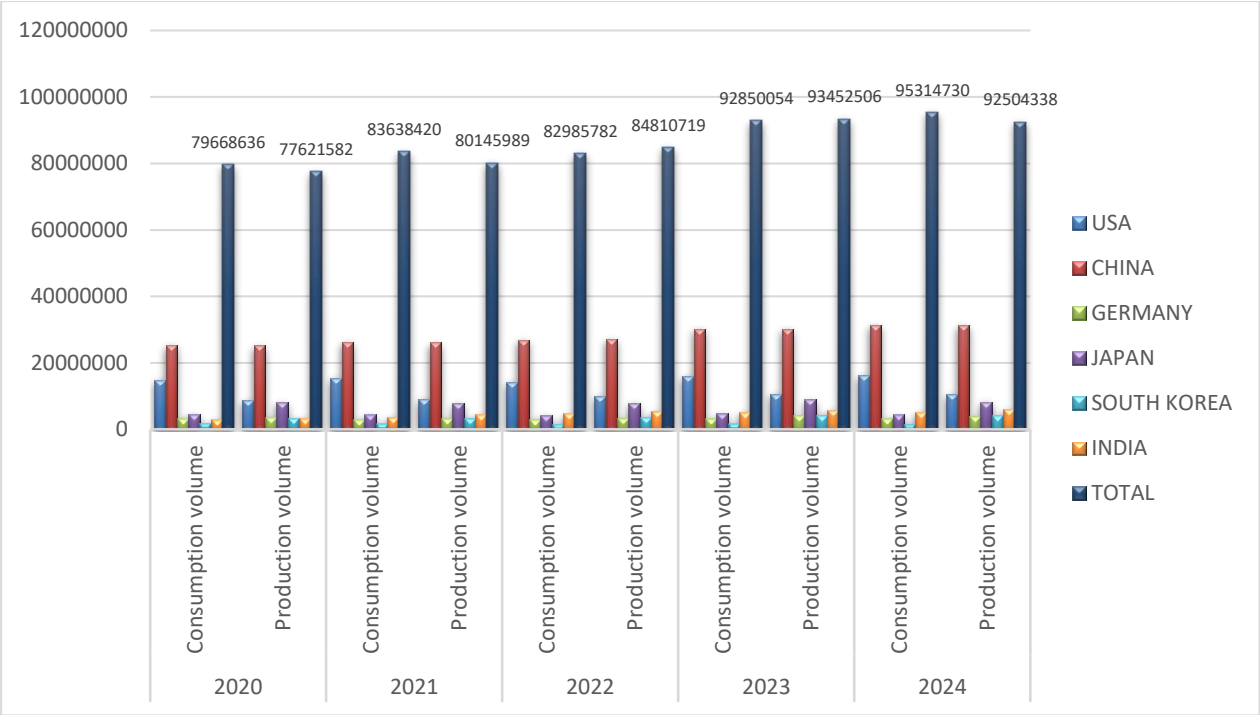

Figure 2. Dynamics of changes in automobile production and consumption volumes in key industry countries, 2020-2024, source: compiled by the authors

China's significance in the global automotive industry has been increasing each year. This concerns not only the size of its domestic market but also the growing competitiveness of Chinese automakers in the global arena. Today, the PRC is the world's largest exporter of automobiles. In 2024, Chinese brands accounted for 34.7% of the entire global market (CPCA, 2025). China's vehicle exports in 2024 reached approximately 5.86 million units, which is 19.3% more than in 2023 (CAAM, 2025). In addition, companies from China are setting new standards in EV architecture, software, and rapid development cycles (GlobalData, 2025).

The second-largest market by volume among the countries presented in Table 3 is the United States. Car consumption in this market declined from 21.4 % in 2020 to 20 % in 2024 of the total global volume. In turn, U.S. production fell from 13.4 % in 2020 to 11.4 % in 2024 on a global scale.

A distinctive feature of this market is that consumption significantly exceeds domestic production – by more than 1.5 times – making it quite attractive for car imports. This situation partly explains the White House administration's policy toward the domestic automotive industry and the import tariffs on foreign vehicles.

At the current stage of automotive industry development, scientific and technological progress, and socio-economic relations, the automobile has outgrown its simple function as a means of transportation. High environmental and safety standards for drivers, passengers, pedestrians, and all road users have turned the car into a kind of gadget. This fact increasingly brings the automotive and technology sectors closer together, blurring the boundaries between them. Companies from both sectors not only cooperate actively but also move into adjacent industries. For this reason, we decided to compare the performance indicators of the market capitalization leaders from both industries as of 2024 (table 4).

Based on the presented data, it can be stated that Tesla is the leader in market capitalization in the automotive market, although its profit and sales volumes are significantly lower than those of Toyota, which ranked second in 2024. The development of technology and the introduction of electric-vehicle support programs in various countries have led to lower costs and greater popularity of such cars. This explains the rapid rise of Tesla as a symbol of the EV segment, although its market share is shrinking under pressure from BYD and new entrants. BYD is the No. 1 EV manufacturer in China and shows the fastest growth among all the presented market leaders: its capitalization has nearly tripled, revenue quadrupled, and profit increased more than sevenfold, allowing the company to take third place in the 2024 ranking.

Analyzing the data in table 3, we can assert that in terms of both market capitalization and profit, the leaders of the technology sector exceed the leaders of the automotive industry by nearly tenfold. This indicates that these companies have far greater resource capacity to enter an adjacent industry with an innovative product compared to traditional automakers. This conclusion is not merely speculative; it has factual confirmation.

Table 4. Dynamics of changes in revenues and profits of companies with the highest market capitalization for 2020-2024, source: compiled by the authors (FML, 2025; Global 500, 2025)

Technological companies							
Rank		1	2	3	4	5	
Company name		Microsoft	Apple	NVIDIA	Alphabet (Google)	Amazon	Total
2020	Market capitalization, billion USD	1543	1670	240	1020	171	4644
	Revenue, billion USD	143	274,5	16,7	182,5	386	1002,7
	Profit, billion USD	44,3	57,4	4,3	40,3	21,3	167,6
2021	Market capitalization, billion USD	2040	2320	490	1680	182	671
	Revenue, billion USD	168	365,8	26,9	257,6	469,8	1288,1
	Profit, billion USD	61,3	94,7	9,8	76	33,4	275,2
2022	Market capitalization, billion USD	2534	3022	1052	1554	1460	9622
	Revenue, billion USD	198,3	394,3	27	282,8	514	1416,4
	Profit, billion USD	72,7	99,8	4,4	59,9	-2,72	234,08
2023	Market capitalization, billion USD	2888	2875	1352	1795	1598	10508
	Revenue, billion USD	211	385	60,9	307,4	575	1539,5
	Profit, billion USD	72,4	96	29,8	73,8	30,4	302,4
2024	Market capitalization, billion USD	3289	3258	3244	2192	1911	13894
	Revenue, billion USD	255	392	114	350	638	1749
	Profit, billion USD	90.5	93.7	63.1	100.1	59.3	406.7
Automobile manufacturers							
Rank		1	2	3	4	5	
Company name		Tesla	Toyota Group	BYD	Ferrari	BMW	Total
2020	Market capitalization, billion USD	670	201	50.2	26.8	43.1	991.1
	Revenue, billion USD	31.5	275.4	23.5	3.8	128.3	462.5
	Profit, billion USD	0.7	19.1	0.6	0.7	5.0	26.12
2021	Market capitalization, billion USD	880	220	131.8	38.3	60.3	1320.4
	Revenue, billion USD	53.8	275.4	32	4.6	131	496,8
	Profit, billion USD	5.5	23.5	1.2	0.9	14.5	45.6
2022	Market capitalization, billion USD	728.9	229	151.9	43.1	58.8	1211.7
	Revenue, billion USD	81.5	284.7	61	5.6	149	581.8
	Profit, billion USD	12.6	23.1	2.4	1.2	18.8	58.1
2023	Market capitalization, billion USD	790	292	141.9	63	76.3	1363.2
	Revenue, billion USD	96.8	293.8	84	6.7	155.5	636.8
	Profit, billion USD	15.0	30.3	4.1	1.3	11.2	61.9
2024	Market capitalization, billion USD	1070	250.3	134.4	82.2	63.3	1600.2
	Revenue, billion USD	105	297	95	8.1	152	657.1
	Profit, billion USD	14.0	31.5	4.4	1.8	7.8	59.5

For example, Apple – one of the leaders of the technology sector – considered creating its own car as the next strategic stage of its development. To this end, the company set up the *Project Titan* division, which for 10 years – from 2014 to 2024 – worked on developing such a vehicle. The idea behind this product was based on three key innovations in the automotive industry:

1. Electrification of the vehicle.
2. Driverless control of the car using an intelligent assistant.
3. Shared ownership and car-sharing.

To implement these innovations, Apple recruited various specialists from the automotive industry, even considered acquiring Tesla, and engaged in cooperation with Didi – the Chinese analogue of Uber. However, Apple's failure to integrate artificial intelligence effectively with the Siri assistant, together with the insufficient profitability of a car-sharing business strategy, forced the company in 2024 to suspend work on Project Titan, and the launch of its own car was pushed back to 2028.

There is, however, a successful example of a tech giant entering the automotive market. Xiaomi, which presents itself as China's analogue of Apple, created the Xiaomi Automobile division in 2021 to develop and manufacture a smart car. Already in December 2023, the company officially unveiled its production EV model, the SU7, with manufacturing set up at BAIC Group's facilities. This move into the automotive industry was not merely an attempt to copy Apple's behavior model, but a search for expansion due to stagnation in the smartphone market and an unwelcome trend of declining revenues and profitability that had persisted for several years (Bloomberg, 2025).
This risky step by Xiaomi proved justified and lifted the company once again. Evidence of the project's success includes 88,898 preorders for the model within the first 24 hours of sales opening, and 157,000 cars sold in the first half of 2025. Although these sales volumes are modest compared to giants like Toyota, which sells more than 10 million vehicles worldwide annually, Xiaomi ranked third by market capitalization among all global automakers in 2024 (Forbes, 2025).
Encouraged by this success, Xiaomi's management is now working to broaden the model range and plans to invest USD 10 billion in car manufacturing over the next 10 years. In 2025, the company launched production of the YU7 crossover, began scaling output by launching its own production facilities, and has plans to enter the European market in 2027.
In our view, the secrets of Xiaomi's automotive success are:

1. A price of around USD 30,000, which is about 10% lower than the nearest competitor, the Tesla Model 3;
2. Seamless integration of the car into the Xiaomi ecosystem, which improves user interaction with the vehicle and optimizes the user's living space and time management.

Based on the above, we can outline the main characteristics of the vehicles that manufacturers will target in the near future:

1. Environmental friendliness – a vehicle with zero CO_2 emissions.
2. A high level of safety through the use of Level-5 autopilot, ensuring autonomous, driverless control of the vehicle.
3. Seamless integration of the vehicle into the user's ecosystem.

Regarding the first point, all leaders of the global automotive industry have developments in this direction. Electrification appears to be the most popular pathway, though alternatives exist. For example, BMW together with Toyota Group has developed a next-generation hydrogen engine whose implementation is planned in the coming years (BMW Group, 2025). This could take competition among eco-friendly cars to a new level. However, despite many companies' work on safety, the next two points narrow the field to just three manufacturers that theoretically have the resources and know-how to deliver a worthy product: Tesla, Apple, and Xiaomi. This is because providing an effective Level-5 autopilot requires not only powerful chips and sensors in the car, but also continuous access to high-speed internet at no less than 5G. The third point is closely related to the second and again hinges on the manufacturer's technological prowess – namely, the existence of a mobile device that serves as an intermediary, unites all the user's gadgets from the coffee machine and computer to the car into a single ecosystem, and runs on proprietary software. Let us consider each of these manufacturers in more detail and compare them.

1. Tesla. The pieces of Elon Musk's diverse business interests are finally fitting into a coherent picture. There is an interest in artificial intelligence, the development of a broad lineup of electric vehicles and a global network of charging stations, and the launch of the Starlink satellite system to provide uninterrupted access to high-speed internet that will cover the entire planet. Thanks to the effective integration of sensors with neural networks, software, and hardware, Tesla cars are poised to obtain Full Self-Driving (FSD) capability; however, under the SAE (Society of Automotive Engineers) standard, its level is currently 2+. Tesla is steadily working to improve it to Level 4 and is currently testing a new beta version. Thus, the company lags in providing fully driverless operation and does not have its own smartphone that would bring together all of Musk's achievements into a single integrated ecosystem.
2. Xiaomi. It has its own EV lineup, enjoying tremendous demand in the domestic market, and the company is making attempts to conquer external markets. The presence of its own mobile devices and an adaptive ecosystem allows the car to be integrated into the owner's life and ensures efficient use of all the user's devices. The corporation is actively working on implementing its *Navigate On Autopilot* system in its vehicles, based on AI algorithms that process data from numerous sensors and make decisions or offer recommendations to the driver. Xiaomi's autopilot is at the same level as Tesla's – namely, 2+. The Chinese corporation's weak point is that it cannot guarantee high-speed internet for its users under all conditions, and existing software bugs and relatively short OS support cycles do not inspire optimism about achieving at least Level 4 autopilot in the near future.
3. Apple. The company has its own lineup of wearable gadgets, manufactures its own chips, offers optimized software, and boasts the most adaptive ecosystem that enables full synchronization among devices and delivers a maximally comfortable and productive user experience. The company is actively implementing satellite communication technology to provide high-quality coverage across the widest possible territory. Unfortunately, Apple failed to realize its potentially promising project to produce its own car. According

to Bloomberg, the main problem was the company's perfectionism and its attempt to release the best possible vehicle immediately with Level-5 autonomy (Bloomberg). However, the fact that Project Titan staff are now involved in developing Apple's own AI model gives hope that the company will indeed revive its EV program by 2028, delivering a car with a high level of autonomy – at least Level 4.

We will now compare the performance indicators of these manufacturers over the past five years and make forecasts regarding possible future developments (table 5).

Table 5. Dynamics of changes in revenues and profits of potential automotive industry leaders for 2020-2024, source: compiled by the authors (FML, 2025; Global 500, 2025)

Company name		Tesla	Xiaomi	Apple	Total
2020	Market capitalization, billion USD	670	144.5	1670	2484.5
	Revenue, billion USD	31.5	14.2	274,5	320.2
	Profit, billion USD	0.7	7.9	57,4	66
2021	Market capitalization, billion USD	880	227.5	2320	3427.5
	Revenue, billion USD	53.8	22.5	365,8	442.1
	Profit, billion USD	5.5	7.5	94,7	107.7
2022	Market capitalization, billion USD	728.9	110.1	3022	3861
	Revenue, billion USD	81.5	18.4	394,3	494.2
	Profit, billion USD	12.6	0.9	99,8	113.3
2023	Market capitalization, billion USD	790	111.6	2875	3776.6
	Revenue, billion USD	96.8	22.2	385	504
	Profit, billion USD	15.0	6.7	96	117.7
2024	Market capitalization, billion USD	1070	172.7	3258	4500.7
	Revenue, billion USD	105	29.6	392	526.6
	Profit, billion USD	14.0	9.1	93.7	116.8

Tesla shows rapid revenue growth from USD 31.5 billion in 2020 to USD 105 billion in 2024. Profitability also increased at an impressive rate; however, in recent years this growth has started to slow down (table 6, fig. 3).

Apple demonstrates steady growth, but in recent years a decline in profitability and overall revenue performance has become noticeable, indicating the need for an adjustment in the company's development strategy.

Xiaomi experienced a drop in market capitalization after 2021 due to competition and sanction-related risks. Since 2023, all key indicators have shown growth, driven by diversification of activities and the company's entry into the automotive market.

Table 6. Forecast of Tesla's profit dynamics for 2025-2028, billion USD, source: compiled by the authors

Year	Profit, billion USD	Prediction (Tesla)	Lower confidence limit (Tesla)	Upper confidence limit (Tesla)
2020	0,7			
2021	5,5			
2022	12,6			
2023	15			
2024	14	14	14,00	14,00
2025		19,28189092	13,93	24,63
2026		22,69022877	17,18	28,20
2027		26,09856662	20,42	31,77
2028		29,50690447	23,67	35,34

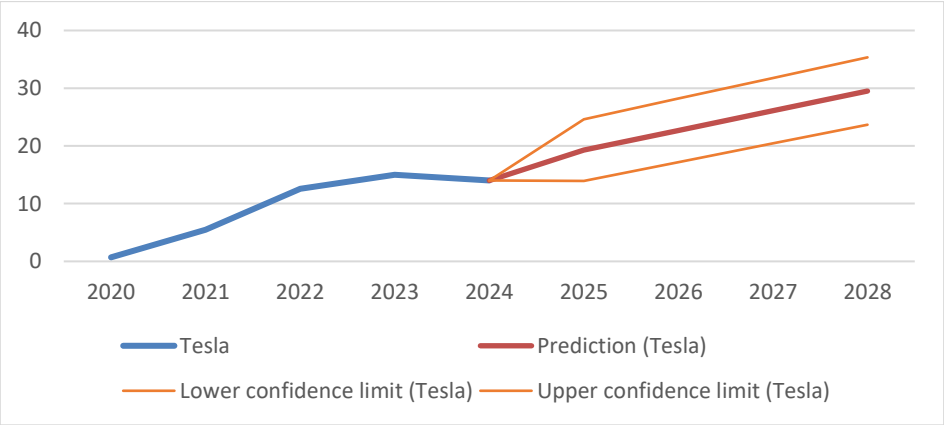

Figure 3. Forecast of Tesla's profit growth for 2025–2028, billion USD, source: compiled by the authors

The exponential smoothing method revealed a trend of recovery and rapid profit growth following a plateau in 2023–2024. For Tesla, a dynamic increase in profitability is projected – nearly doubling from USD 14 billion in 2024 to almost USD 30 billion by 2028. However, the observed variation within the confidence intervals can be explained by the company's dependence on the electric vehicle market, intensifying competition, and overall economic instability. Nevertheless, the general baseline trend remains consistent across all scenarios, indicating sustained profit growth.

According to the forecast data, Apple (table 7, fig. 4) is expected to continue increasing its profits after 2024. The exponential smoothing method indicates a trend of short-term decline followed by long-term profit growth. The confidence intervals suggest potential risks of deviation -driven by competition, regulatory actions, and the innovation cycle – but the baseline scenario remains stable, predicting steady and sustainable growth.

Table 7. Forecast of Apple's profit dynamics for 2025-2028, billion USD, source: compiled by the authors

Year	Profit, billion USD	Prediction (Apple)	Lower confidence limit (Apple)	Upper confidence limit (Apple)
2020	57,4			
2021	94,7			
2022	99,8			
2023	96			
2024	93,7	93,7	93,70	93,70
2025		105,7698911	74,68	136,86
2026		112,444182	77,67	147,22
2027		119,1184729	81,00	157,24
2028		125,7927638	84,59	167,00

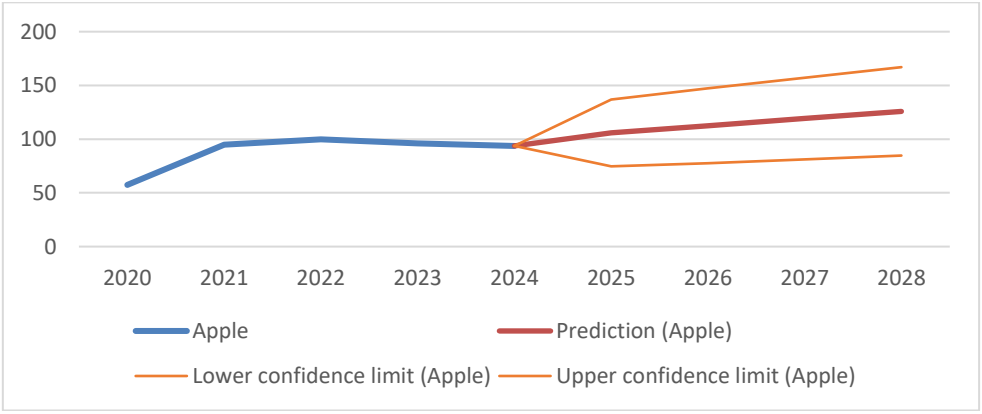

Figure 4. Forecast of Apple's profit growth for 2025-2028, billion USD, source: compiled by the authors

The forecast constructed using the exponential smoothing method for Xiaomi (table 8, fig. 5) suggests gradual recovery following unstable performance during 2020-2023. The graph shows a smooth positive trend for Xiaomi in the medium term; however, the wide fluctuations between the confidence intervals indicate significant risks. This means the company's future results could be either remarkably positive or severely negative. Such a substantial divergence reflects the company's high-risk strategy and rather fragile position, making it heavily dependent on market conditions and external factors.

Table 8. Forecast of Xiaomi's Profit Dynamics for 2025–2028, billion USD, source: compiled by the authors

Year	Profit, billion USD	Prediction (Xiaomi)	Lower confidence limit (Xiaomi)	Upper confidence limit (Xiaomi)
2020	7,9			
2021	7,5			
2022	0,9			
2023	6,3			
2024	9,1	9,1	9,10	9,10
2025		8,087687659	1,16	15,02
2026		8,484740649	1,34	15,63
2027		8,881793639	1,53	16,24
2028		29,50690447	23,67	35,34

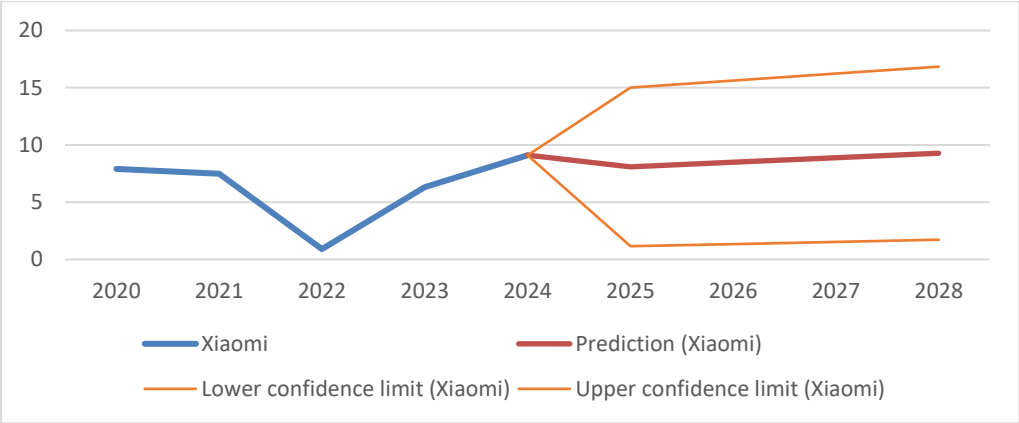

Figure 5. Forecast of Xiaomi's profit growth for 2025-2028, billion USD, source: compiled by the authors

Thus, the conducted analysis shows that among the three potential industry leaders, Tesla has the most stable forecast, demonstrating the fastest growth and potentially doubling its profit by 2028. Apple maintains the largest profit size among the three, but its growth rate is considerably slower than Tesla's, and the wider gap between its forecast confidence bands indicates a higher level of strategic risk. The situation could significantly improve – and the trend could move toward the upper confidence line – if Apple releases a new innovative product, potentially its own electric vehicle. The most unstable forecast belongs to Xiaomi, which faced profitability issues in its traditional market. However, its risky yet strategically sound decision to enter the automotive market with its own EV could become a turning point in the company's development and significantly improve its performance.

The obtained research results are highly significant from the standpoint of achieving the Sustainable Development Goals (SDGs), as they demonstrate the deep interconnection between digitalization processes, the innovative development of the automotive industry, and the ecological transformation of the global economy. A comparative analysis of the leading automakers and technology companies revealed that global trends in automotive manufacturing directly contribute to the achievement of SDGs 7, 9, 11, 12, and 13, as defined by the United Nations.

First, the rapid expansion of the electric vehicle market – led by companies such as Tesla, BYD, and BMW, along with Xiaomi's entry and Apple's potential return – confirms the priority of Goal 7 – Affordable and Clean Energy. The large-scale introduction of electric and hydrogen-powered vehicles reduces dependence on fossil fuels, promotes the development of renewable energy, and lowers CO_2 emissions. In 2024 alone, the share of EVs in global sales exceeded 18%, reflecting the systemic integration of technological innovation into transport infrastructure.

At the same time, the active digitalization of production – through the use of artificial intelligence, cloud technologies, sensor systems, and big data – contributes to Goal 9 – Industry, Innovation, and Infrastructure. Notably, the market capitalization of technology corporations (Apple, Microsoft, NVIDIA) is nearly ten times higher than that of automotive leaders, indicating an investment shift toward the *smart industry* and the synergy between high

technology and mechanical engineering. This process forms the basis for a new industrial revolution, in which the automobile becomes an integral element of the user's digital ecosystem.
The development of smart transportation systems, car-sharing, and autonomous vehicles promotes the achievement of Goal 11 – Sustainable Cities and Communities, by reducing traffic congestion, noise pollution, and harmful emissions. A vivid example is the Chinese model of urban mobility, where, supported by government policies and domestic demand, EV sales in 2024 reached 38.3% of all vehicles sold nationwide. This dynamic demonstrates the emergence of a sustainable urban environment.
The advancement of the circular economy and the reduction of production material intensity contribute to Goal 12 – Responsible Consumption and Production. The implementation of battery recycling technologies, eco-friendly materials, and digital vehicle lifecycle monitoring systems enhances resource efficiency and minimizes waste.
Finally, achieving Goal 13 – Climate Action is reflected in the strategic intentions of major corporations to decarbonize production. Profit forecasts indicate that EV manufacturers not only maintain profitability but also ensure the ecological sustainability of their business models. For instance, Tesla's profit is projected to grow from USD 14 billion in 2024 to USD 29.5 billion in 2028, confirming the economic viability of investing in green technologies.
In conclusion, the study proves that the synergy between the automotive and technology sectors is one of the key drivers of global sustainable development. It ensures not only innovation and competitiveness but also fosters an environmentally safe, socially responsible, and economically resilient future for the global economy.

6. Conclusions

Despite the fact that traditional automobile manufacturers currently hold stable positions – characterized by consistent profitability and steady revenue growth – the market capitalization of these companies is increasing much more slowly compared to new entrants such as Tesla, BYD, and Xiaomi. This reflects a structural transformation of the market, where the advantage is gradually shifting toward innovation-oriented corporations capable of integrating technological advancement, environmental sustainability, and digital connectivity into a unified business model.
The orientation toward new automotive trends is linked to the transformation of vehicles into high-tech devices integrated into the user's digital ecosystem, featuring high levels of autonomy, safety, and energy efficiency. These vehicles are controlled through intelligent interfaces, artificial intelligence, and mobile applications, fundamentally changing the paradigm of transportation consumption. Therefore, the future leaders of the automotive market are likely to be Tesla, Apple, and Xiaomi, as they combine technological flexibility with a strategic focus on *green* innovation.
Transformational processes in the industry have already begun, and the electrification of vehicles is merely the first stage of a deeper shift in the production and technological base. Competition in the market is intensifying: the tech giant Huawei is actively collaborating with leading Chinese automakers (SAIC, BYD, JAC, GAC, BAIC, Chery) to develop electric cars with built-in autopilot systems integrated into the Harmony Intelligent Mobility Alliance (HIMA) digital ecosystem, based on its proprietary HarmonyOS (Huawei, 2025). Such a symbiosis between the technology and automotive sectors contributes directly to the realization of the UN Sustainable Development Goals (SDGs) – in particular, Goals 7, 9, 11, 12, and 13, which focus on clean energy, innovation, sustainable cities, responsible production, and climate action.
At the same time, contemporary researchers highlight a number of challenges that complicate the achievement of these goals in the context of the automotive industry.
According to Vijaya et al. (2025), the sector remains insufficiently prepared for the full integration of ESG environmental standards into corporate strategies, which limits the effectiveness of decarbonization efforts. Glova & Panko, 2025 note the risk of a short-term decline in profitability due to high costs of implementing *green* technologies, potentially constraining investment activity in the medium term. Avasilcăi et al., 2025 emphasize the problem of *digital inequality* between countries, as the innovation infrastructure required for e-mobility and sustainable consumption is concentrated mainly in developed economies. Moreover, Lopez-Vega et al., 2023 argue that digitalization introduces new challenges in energy consumption, cybersecurity, and data accessibility, calling for cross-sectoral regulation.
Scholarly discussion also indicates that the transition to sustainable mobility requires not only technological innovation but also profound socio-economic changes. Pérez-Moure et al., 2023 emphasize that the development of autonomous and connected transport systems without proper regulation may lead to inequality in access to *smart* mobility, particularly in developing countries. Thus, the key challenge for the global automotive industry remains the balance between economic efficiency (Kozlovskyi et al., 2025), social equity, and environmental sustainability.
In summary, it can be stated that the automotive industry is undergoing a deep transformation driven by digitalization and the implementation of sustainable development principles. These changes have the potential to become a powerful driver of scientific and technological progress, the formation of a *green* industrial policy, and the

achievement of balanced economic growth, provided that innovative, environmental, and socially responsible approaches are effectively integrated into the industry's development strategy. At the same time, the integration of digital and automotive technologies remains in its early stages and requires substantial investment, regulatory support, and governmental coordination. Despite these challenges, the convergence of the automotive and technology sectors marks the beginning of a new era of innovation, enhancing urban mobility efficiency, shaping the architecture of smart cities, and making a tangible contribution to the global implementation of the Sustainable Development Goals (Pamucar et al., 2023).

References

1. AVASILCĂI S., GAVRILUȚĂ A., POPESCU D., 2025, *Digital technologies to support sustainable consumption: An overview of the automotive industry, Sustainability,* 17(15), 7047, https://doi.org/10.3390/su17157047.
2. BLOOMBERG, 2025, https://www.bloomberg.com/news/articles/2025-07-06/xiaomi-founder-s-bold-ev-bet-is-paying-off-where-apple-s-failed.
3. BMW GROUP, 2025, https://www.press.bmwgroup.com/global/article/detail/T0452737EN/from-pilot-fleet-to-series-production-the-new-bmw-ix5-hydrogen.
4. CAAM (China Association of Automobile Manufacturers), 2025, http://www.caam.org.cn/english.
5. CHATTERJEE S., SIMONOFF S., 2013, *Handbook of Regression Analysis Copyright,* https://onlinelibrary.wiley.com/doi/book/10.1002/9781118532843/.
6. CPCA (China Passenger Car Association), 2025, China hits record auto sales with 41% market share as of Dec., *China Daily*, https://www.chinadailyhk.com/hk/article/604163.
7. DIMITRAKOPOULOS G., TSAKANIKAS A., PANAGIOTOPOULOS E., 2021, *Autonomous Vehicles Technologies, Regulations, and Societal Impacts,* Elsevier, https://doi.org/10.1016/C2020-0-02875-6.
8. DOW JONES, 2025, https://www.dowjones.com.
9. IEA (International Energy Agency), (2024), *Global EV Outlook 2024,* https://www.iea.org/reports/global-ev-outlook-2024/.
10. EULERPOOL RESEARCH SYSTEMS, 2025, https://eulerpool.com/en/stock/.
11. FORBES, 2025, https://forbes.ua.
12. FORTUNE.COM, 2025, *Global 500*, https://fortune.com/ranking/global500/.
13. FUSION MEDIA LIMITED, 2025, https://uk.investing.com/.
14. GLOBAL DATA, 2025, *China's Impact on the Automotive Industry: Strategic Intelligence,* https://www.globaldata.com/store/report/china-impact-automotive-theme-analysis/.
15. GLOVA J., PANKO L., 2025, The effects of environmental, social, and governance factors on financial performance and market valuation in the European automotive industry, *Journal of Risk and Financial Management,* 13(2): 82, https://doi.org/10.3390/jrfm13020082.
16. HUAWEI, 2025, https://digitalpower.huawei.com/en/blogs/power-domain-solutions-ev-driveone-avatr.
17. ISHCHUK S.O., 2022, *Development of mechanical engineering in Ukraine: problems and ways to solve them: monograph,* Institute of Regional Research named after M.I. Dolishniy of NAS of Ukraine: 137 p. (in Ukrainian.).
18. JAMA (Japan Automobile Manufacturers Association), 2025, *The Motor Industry of Japan*, https://www.jama.or.jp.
19. KOZLOVSKYI S., BOLHOV V., YOUSUF A., BATECHKO A., HLUSHCHENKO L., VITKA N., 2019, Marketing analysis of the electromobile market as a factor in the innovation of the national economy, *Innovative Marketing,* 15(1), http://dx.doi.org/10.21511/im.15(1).2019.04.
20. KOZLOVSKYI S., KULINICH T., DUSZYŃSKI M., POPOVSKYI T., DLUHOPOLSKA T., KORNATKA A., POPOVSKYI Y., 2025, Forecasting Demand for Eco-Friendly Vehicles Using Machine Learning Technologies in the Era of Management 5.0, *Sustainability,* 17(10): *4429,* https://www.mdpi.com/2071-1050/17/10/4429.
21. LOPEZ-VEGA H., PIHLAJAMAA M., DE VISSER M., 2023, Digital transformation of the automotive industry, *Industry and Innovation,* 30(8): 1351-1373, https://doi.org/10.1080/13662716.2022.2151873.
22. MACCARTHY B.L., IVANOV D., 2022, *The Digital Supply Chain – emergence, concepts, definitions, and technologies,* Elsevier Science: 464 p.
23. MARRA A., SUN L., CORMAN F., 2022, The impact of COVID-19 pandemic on public transport usage and route choice: Evidence from a long-term tracking study in an urban area, *Transport Policy,* 116: 258–268, https://doi.org/10.1016/j.tranpol.2021.12.009.
24. MCKINSEY & COMPANY, *Automotive & Assembly reports*, https://www.mckinsey.com/industries/automotive-and-assembly.
25. MOGAJI E., 2025, *Transformative transport services: leveraging sustainability, inclusivity, and technology through marketing management,* Journal of Marketing Management, https://doi.org/10.1080/0267257X.2025.2461673.
26. OECD STAN, 2025, *Structural Analysis Database* (Manufacturing, ISIC Rev. 4: 29 – Motor vehicles, trailers and semi-trailers).
27. OICA (International Organization of Motor Vehicle Manufacturers), 2025, https://www.oica.net.
28. PAMUCAR D., DEVECI M., GOKASAR I., DELEN D., KÖPPEN M., PEDRYCZ W., 2023, Evaluation of metaverse integration alternatives of sharing economy in transportation using fuzzy Schweizer-Sklar based ordinal priority approach, *Decision Support Systems*, 171, https://doi.org/10.1016/j.dss.2023.113944.
29. PÉREZ-MOURE M., SOTO-ACOSTA P., RAMÓN-JERÓNIMO M., 2023, How sustainable, autonomous, and connected vehicles are changing digital mobility business models, *Sustainability,* 15(21): 15746, https://doi.org/10.3390/su152115746.

30. RHO MOTION, 2025, *Over 17 million EVs sold in 2024 – Record Year*, https://rhomotion.com/news/over-17-million-evs-sold-in-2024-record-year/.
31. PwC, 2024, *Global Automotive Outlook 2024: Driving transformation in a digital world,* PricewaterhouseCoopers International Limited, https://www.pwc.com/gx/en/industries/automotive.html.
32. SIAM (Society of Indian Automobile Manufacturers), 2025, https://www.siam.in.
33. STATISTA, 2025, *Automotive industry worldwide*, https://www.statista.com/topics/1487/automotive-industry/.
34. VIJAYA R., BANDYOPADHYAY A., KUMAR V., 2025, *Advancing sustainability in the automotive sector: A critical analysis of environmental, social and governance (ESG) performance indicators*. *Environmental Science and Pollution Research,* 32(9): 11756-11770, https://doi.org/10.1007/s11356-025-31784-x.
35. VIRTA, 2025, *The Global Electric Vehicle Market in 2025*, https://www.virta.global/global-electric-vehicle-market.
36. WANG Y., SHEN Q., ASHOUR L., DANNENBERG A., 2022, Ensuring equitable transportation for the disadvantaged: paratransit usage by persons with disabilities during the COVID-19 pandemic, *Transp. Res. A Policy Pract.,* 159: 84-95, https://doi.org/10.1016/j.tra.2022.03.013.
37. WORLD BANK, 2025, *World Development Indicators*, https://databank.worldbank.org/source/world-development-indicators.