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China's New Energy Vehicles in the Context of Artificial Intelligence: Challenges and Development

Zihan Zhang[1,a,*]

[1]*High School Affiliated to Renmin University of China, Beijing, China*
a. liujingfei@bisu.edu.cn
**corresponding author*

Abstract: The integration of Artificial Intelligence (AI) into China's New Energy Vehicle (NEV) industry presents both unprecedented opportunities and significant challenges. Through analyzing the present situation of the NEV market in China, this paper identifies key challenges posed by AI, and proposes strategic countermeasures. Even though the NEV industry is growing rapidly, there are still a number of significant obstacles that NEVs must overcome. Technologically, algorithms, computing power and sensor fusion are critical. Regulatory challenges include preventing data leakage and protecting privacy. Economically, the need for substantial investments in infrastructure poses significant hurdles. Socially, changing market operation and reskilling the workforce are essential. The challenges faced by New Energy Vehicles (NEVs) will drive significant technological innovation and cooperation, particularly in algorithm optimization, hardware upgrade and sensor fusion technology. Regulatory influences will push for network security and enhancing safety and compliance. Economic impacts include the need to improve charging network, build an intelligent transport system and improve information and communication infrastructure. Socially, addressing market operation and workforce reskilling will be crucial. Overall, these challenges will shape market dynamics, competitive landscapes, and global supply chains, ultimately driving the NEV sector towards more sustainable and efficient solutions, and by these measures, China can fortify its NEV industry against AI-related challenges and achieve sustainable growth.

Keywords: New energy vehicles, Artificial Intelligence, data leakage, protecting privacy.

1. Introduction

The New Energy Vehicle (NEV) industry is only one of many businesses that have undergone radical change since the introduction of artificial intelligence (AI). The shift from conventional internal combustion engine vehicles to NEVs has accelerated as environmental sustainability and climate change concerns grow on a worldwide scale. China, one of the biggest auto marketplaces in the world, has become a major force in the NEV market. In an effort to lessen the nation's reliance on fossil fuels and its carbon footprint, the Chinese government has put in place a number of measures that encourage the use of NEVs.

By improving vehicle function, security, and user experience, artificial intelligence (AI) technologies—such as machine learning, big data analytic, and autonomous driving—have the

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potential to completely change the NEV market. However, integrating AI also presents a number of issues that must be resolved to guarantee the long-term growth of the NEV industry.

The purpose of this paper is to present a thorough study of the current situation in Chinese NEV industry, clarify the difficulties posed by AI, and propose feasible countermeasures.

2. Development of China's NEV Industry

One of the biggest NEV marketplaces in the world, China's NEV sector has made great strides in recent years.

2.1. Market Size

The development of the NEV industry in China will be analyzed according to aspects of production, sales, exports, industry chain, and business models.

According to China Association of Automobile Manufacturers (CAAM), in July 2024 NEV production and sales reached 984,000 and 991,000, respectively, signifying growths of 22.3% and 27% on an annual basis. Production and sales of NEVs have increased by 28.8% and 31.1%, respectively, from January to July 2024, to 5.914 million and 5.934 million. Domestic NEV sales in July 2024 were 887,000 units, a 7.9% month-over-month decline and a 30.7% year-over-year gain. Domestic NEV sales have increased by 34.3% year over year to 5.226 million units between January and July 2024. The export of NEVs reached 103,000 units in July 2024, a 20.6% month-over-month and 2.2% year-over-year rise. NEV exports totaled 708,000 units between January and July 2024, an 11.4% rise from the previous year [1].

China's NEV industry chain is comprehensive, covering upstream raw material supply, midstream battery and motor manufacturing, and downstream vehicle manufacturing and sales.

The upstream raw materials are the key battery materials such as lithium, cobalt, and nickel. China has a competitive edge in lithium resources, with domestic companies like Tianqi Lithium, holding significant positions in the global market. About the midstream battery manufacturing, China has the largest production capacity for power batteries globally, with major companies including CATL (Contemporary Amperex Technology Co. Limited) and BYD (Build Your Dream). The core components of motor and control Systems are produced by well-established companies such as United Automotive Electronic Systems and Inovance Technology. The Major players of downstream vehicle manufacturing include BYD, NIO, Xpeng, and Li Auto. The supporting infrastructure include rapid development in charging stations and battery swapping stations, with companies like State Grid Corporation of China and Teld New Energy actively involved.

The business models in China's NEV industry are diverse, including Direct Sales Model: Companies like Tesla and NIO sell directly to consumers through online platforms and self-operated experience centers, eliminating intermediaries and enhancing user experience; Traditional Dealership Model: Some traditional automakers like BYD still rely on conventional dealership networks for sales; Subscription Services: NIO offers subscription services, allowing users to pay monthly fees to use vehicles, providing greater flexibility; Battery Leasing: Companies like NIO offer battery leasing options, reducing the upfront cost of purchasing an NEV; and Battery Swapping: NIO's innovative battery swapping model enables quick battery replacement at swapping stations, addressing the issue of long charging times.

China's NEV industry demonstrates strong growth in production, sales, a well-established industry chain, and varied business models. With ongoing technological advancements and continued policy support, the Chinese NEV industry is poised for sustained growth in the future.

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2.2. Technological Innovation

China has also made significant progress in technological innovation of new energy vehicles. The research and development investment in fields such as battery technology and autonomous driving is constantly increasing.

There are some innovations in Lithium batteries. The latest lithium battery technology has significantly improved energy density, allowing electric vehicles to store more energy in a smaller and lighter package, thereby extending driving range. By improving battery materials and charging technology, new lithium batteries can be charged in a much shorter time, significantly reducing charging duration. The use of new electrolytes and separator materials reduces the risk of overheating, fires, and explosions, thus enhancing the safety of electric vehicles. The new generation of lithium batteries has optimized chemistry and structural design, which significantly extends battery life, reducing the frequency of replacements and maintenance costs. Advances in production technology and economies of scale have gradually reduced the manufacturing costs of lithium batteries, making new energy vehicles more economically viable.

The advanced technologies have led to the innovations in autonomous driving. The adoption of more precise lidar, cameras, and radar sensors has improved the environmental perception capabilities of autonomous driving systems. Advanced AI and machine learning algorithms enable autonomous driving systems to better understand and predict road conditions and pedestrian behavior, enhancing the accuracy and safety of driving decisions. Utilizing high-precision maps and real-time localization technology, autonomous vehicles can navigate more accurately, ensuring driving safety and route optimization. Autonomous vehicles leverage V2X technology to communicate with other vehicles and infrastructure, improving traffic flow efficiency and safety. The introduction of redundancy designs and fault-tolerant mechanisms in autonomous driving systems ensures that the system can operate safely even if some components fail.

These innovations significantly enhance the performance, safety, and user experience of new energy vehicles, driving the advancement of the entire industry.

2.3. Infrastructure Construction

One crucial requirement for encouraging the use of new energy vehicles is the development of charging infrastructure. China has advanced significantly in this area as well. Major cities and highway networks will have 2.726 million public charging piles by the end of 2023, comprising 1.203 million DC charging piles and 1.522 million AC charging heaps. In December 2023, there were 100,000 more public charging piles than in November, representing a 51.7% increase year over year. NEV customers now have more convenient options because to the gradual promotion of wireless charging technology and battery switching modes [2].

Overall, China's NEV industry has made significant achievements in market size, policy support, technological innovation, and infrastructure construction. These achievements have not only driven the development of the domestic market, but also enabled China to occupy an important position in the global NEV industry. In the future, with further technological advancements and continued policy support, China's NEV industry is expected to maintain rapid growth and become an important force in promoting green transportation and sustainable development.

3. The Challenges Brought by Artificial Intelligence

The NEV industry has seen previously unheard-of prospects as a result of the quick development and broad use of artificial intelligence (AI) technologies. The use of AI technology has, nevertheless, also presented a number of new difficulties. These difficulties encompass a variety of factors, including

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infrastructure, market competition, and data security, in addition to technical ones. This paper examines these issues in depth by integrating previous studies and reports.

3.1. Technological Bottleneck

The application of AI technology in the NEV industry faces multiple technological bottlenecks.

Algorithm complexity is one of the major challenges facing NEV technology. Existing AI algorithms still have certain limitations in areas such as autonomous driving and intelligent management. The complex road environment and unexpected situations have raised higher requirements for the decision-making ability and response speed of AI systems. Research has shown that current deep learning algorithms still have shortcomings in handling unlabeled data and responding to unexpected situations [3].

The insufficient computing power needs improving. The application of AI technology requires strong computing power, but currently many NEVs' computing hardware cannot meet the needs of complex AI algorithms. Especially in the field of autonomous driving, the high computational demands of real-time data processing and decision-making pose a significant challenge.

Sensor fusion is also a big challenge to the NEV technology. The auto drive system relies on multiple sensors (such as cameras, radar, and lidar) to get environmental information, and efficient fusion and processing of these sensor data remains a major challenge. The inconsistency of sensor data and the processing of redundant information are current issues that need to be addressed.

3.2. Data Security and Privacy

With the intelligence and networking of NEVs, a large amount of data is collected and processed, and the security and privacy protection of this data have become important issues.

There is a big risk of the data leakage in the NEV technology. The massive amount of data collected during vehicle operation, including geographic location, driving behavior, vehicle status, may be hacked and leaked, posing serious security risks. In the past few years, multiple automobile manufacturers have encountered various forms of cyber-attacks.

Privacy protection is a great concern in the NEV industry. Consumers have increasingly high demands for personal privacy protection. How to effectively protect user privacy in the process of data collection and use is a challenge that both enterprises and governments need to face together.

Data compliance should be given great attention. Different countries and regions have different laws and regulations on data protection, and multinational new energy vehicle companies need to ensure that their data management complies with local legal requirements. This has increased the complexity and cost of enterprise data management.

3.3. Infrastructural Inadequacies

Effective application of artificial intelligence technology cannot be separated from a sound infrastructure, but the current infrastructure construction still relies on charging networks. Although the number of charging piles is constantly increasing, problems such as uneven layout of charging networks, inconsistent charging equipment standards, and slow charging speeds still exist. These issues have affected the charging experience of new energy vehicle users.

The application of AI technology in intelligent transportation systems is still in its early stages and lacks the ability for global optimization and collaborative management. For example, intelligent traffic signal systems, vehicle road coordination systems. still need further improvement.

The intelligence and networking of new energy vehicles require high-speed and stable information and communication network support, but currently the communication infrastructure in some regions cannot meet the demand.

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3.4. Fierce Market Competition

The application of AI technology has brought new dimensions of competition to the new energy vehicle market.

Technological competition brings a big challenge for China's NEV industry. Domestic and foreign enterprises are continuously increasing their investment in AI technology research and development, and technological competition is extremely fierce. Leading technological advantages have become an important factor for enterprises to stand out in the market.

Market operation is an important link to improve international competiveness. International manufacturers have certain advantages in brand influence and market operation experience, while domestic enterprises need to continuously improve in technological innovation, brand building, and market operation in order to occupy a place in the fierce market competition.

Attention must also be paid to the talent shortage. The demand for high-end talent has increased due to the rapid development of AI technology, but the industry's growth is severely constrained by the current lack of highly skilled workers in new energy vehicle and AI technologies.

The new energy vehicle sector has benefited greatly from artificial intelligence (AI), but there are drawbacks as well, including difficulties with infrastructure, data security, technology, and market rivalry. The government, businesses, and research institutions must work together to address these issues and support the industry's sustainable growth through a variety of strategies, including policy advice, infrastructure development, technical innovation, and talent development.

4. Countermeasures and Prospects of Artificial Intelligence in the Application of New Energy Vehicles

The application of AI technology in NEVs faces multiple challenges, but these challenges can be alleviated and resolved by taking effective measures. This paper will explore these strategies and look forward to future development directions.

4.1. Technological Innovation and Cooperation

Algorithm plays an important role in NEV industry, needing to be optimized. Existing AI algorithms have limitations in handling complex road environments and unexpected situations. Future research should focus on optimizing algorithms to improve their robustness and adaptability in practical applications. New algorithms such as reinforcement learning and generative adversarial networks (GANs) are expected to make breakthroughs in this area. The continuous innovation and integration of intelligent decision-making systems and path planning algorithms will provide strong technical support for the rapid development of the new energy vehicle industry [4].

Computing hardware is an essential part of the AI technology and should be upgraded. With the development of AI technology, NEVs require more powerful computing capabilities. Enterprises should invest in the research and development of high-performance computing hardware, such as special AI chips and edge computing devices, to meet the requirements of real-time data processing and decision-making.

Sensor fusion technology also needs to be advanced. The sensor data fusion technology should be further improved to enhance the efficiency and accuracy of multi-sensor collaborative work. Through deep learning and sensor data fusion techniques, fault signal detection and higher precision environmental perception can be achieved [5].

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4.2. Data Security and Privacy Protection

The measures of enhancing network security, such as establishing a sound data security protection system and adopting encryption technology, multi factor authentication should be taken to prevent data leakage and hacker attacks in the NEV industry. Blockchain technology has potential in data security and privacy protection, and can be used for distributed data management and access control. A new energy vehicle sharing platform based on blockchain technology can create a secure, transparent, and efficient sharing ecosystem [6].

Privacy protection technologies, such as differential privacy and federated learning to protect users' privacy during data analysis, should be advanced. Federated learning will allow multiple vehicles or devices to jointly train AI models without sharing raw data, thereby protecting data privacy.

Data compliance should be incorporated in the enterprise management system. Enterprises need to establish a dedicated data compliance team to ensure that data management complies with local laws and regulations. Regularly conduct data security audits and risk assessments to promptly identify and resolve potential issues.

4.3. Infrastructural Construction

A comprehensive charging network is a key factor in the operation of NEVs, so the government and enterprises should work together to expand the coverage of charging stations, optimize the layout of the charging network, improve the interoperability and charging speed of charging equipment, and utilize high-efficiency charging technology and intelligent control algorithms based on big data analysis and machine learning methods [7].

A 5G intelligent transportation system is also important in the successful working of NEVs. The construction of intelligent transportation systems should be accelerated and the level of intelligence in traffic management should be improved. The 5G intelligent management system leverages advanced technologies such as data mining, big data analysis, cloud storage, BIM (Building Information Modeling) technology, GIS (Geographic Information System) technology, and distributed computing. It enables the aggregation and preliminary processing of large-scale data, data desensitization and cleansing, standardized conversion, big data mining, data exchange and sharing, intelligent video analysis, and dynamic management. These capabilities support the realization of digital control, safe transit, and multidimensional service areas [8].

Improving information and communication infrastructure is a great step to take, like promoting the construction and popularization of 5G networks and providing high-speed and stable communication support for the intelligence and networking of new energy vehicles. 5G technology can significantly improve data transmission speed and connection stability, providing strong support for applications such as autonomous driving [9].

4.4. Market Operation and Talent Cultivation

Facing the fierce market competitiveness, there is an urge to promote market operation and cultivate talents in China's NEV industry.

Market promotion and brand building are essential parts of market operation. Enterprises should pay attention to brand building and market promotion and improve consumers' awareness and acceptance of intelligent NEVs. Optimizing users' experience and improving after-sales service can lead to enhancing market competitiveness.

Increasing efforts should be made to cultivate AI and NEV technology talents. Universities, research institutions, and enterprises need to closely cooperate to establish specialized training programs and practical training projects to enhance the technical and practical abilities of talents and

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promote technical standardization in the fields of AI and NEVs. Standardization helps to reduce research and development costs, improve technology compatibility and interoperability.

5. Conclusion

The application of AI technology in the NEV industry has brought tremendous opportunities and changes to this field. However, with this change come many challenges. These challenges mainly focus on technological bottlenecks, data security and privacy, inadequate infrastructure, and market competition.

Firstly, the existing AI algorithms and computing power are not yet sufficient to fully meet the requirements of autonomous driving in complex road environments. The improvement of sensor fusion technology and the upgrading of hardware equipment will be the key to solving this problem. Secondly, data security and privacy protection issues urgently need to be addressed. By adopting new technologies such as encryption, block chain, and federated learning, data security and user privacy protection can be effectively improved.

Infrastructure-wise, the development of intelligent transportation systems, the expansion of charging networks, and the upgrading of information and communication infrastructure are crucial pillars supporting the broad adoption of new energy vehicles. 5G technology will offer robust communication support for intelligent connected vehicles, particularly as it becomes more widely used. Additionally, as market competition heats up, technological collaboration and standardization, talent development, and brand building are critical tactics for businesses to differentiate themselves.

In the future, intelligent new energy cars will become more and more crucial in fostering the growth of green transportation and smart cities due to ongoing technological advancements and regulatory assistance. The new energy vehicle sector will undoubtedly bring in even more exciting opportunities through multi-party cooperative efforts to overcome the numerous issues currently facing the sector.

In summary, artificial intelligence has a wide range of potential applications in new energy vehicles, but there are also numerous obstacles to overcome. These issues can be successfully resolved by initiatives in infrastructure development, data security protection, technology innovation, and talent development. With the market's maturity and ongoing technological advancements, intelligent new energy vehicles will play a significant role in advancing the creation of green transportation and smart cities.

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