Analysis of the Impact of AI on the Car Industry - taking BYD Co., Ltd as an Example

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Abstract

The manufacturing industry is the pillar of the national economy and the foundation of national power. With the development of China's economy and society, as well as the improvement of science and technology, the transformation and upgrading of China's manufacturing industry is also more urgent. At present, in the field of manufacturing, artificial intelligence technology and manufacturing technology are constantly integrating, gradually forming intelligent an manufacturing base. As the core industry of China, the car industry embodies mechanisation, automation, and intelligence, and artificial intelligence is now widely applied in this industry. Representative technologies such as speech recognition and computer vision have brought intelligent and convenient experiences to the car industry and car companies themselves, improving safety, innovation, and efficiency. The current Chinese car industry has made significant progress in the application of artificial intelligence, and has made many breakthroughs in research, development, and production. This report takes BYD auto company, which has occupied a large market share in recent years, as an example. Based on previous annual financial reports and some literature in related fields, this report analyses the impact of artificial intelligence on the development of the BYD enterprise. At the same time, this report studies this company's current application of artificial intelligence and explores the possibility of wider application of artificial intelligence in the automotive industry and enterprise development.

Keywords: *BYD Co. Ltd*; *artificial intelligence*; *automotive industry*; *efficiency*

1 Background

1.1 The Definition of Artificial Intelligence and its Development

Artificial intelligence, as a branch of computer science, simulates certain human thinking processes and intelligent behaviors through machine learning, which is the simulation and extension of human intelligence. The terminology "artificial intelligence" was first proposed at the Dartmouth Conference in 1956 and has a history of over 60 years. In the early days, artificial intelligence was represented as rule-based AI systems that could only conduct some basic instructions. After years of development, now artificial intelligence can achieve thinking and reasoning. Due to the characteristics of artificial intelligence being based on human intelligence simulation and integrating it with computers, it can replace human resources in many fields. In the future, as human intelligence is applied to more fields, human life will also become more convenient.

1.2 Application and Development of Artificial Intelligence in China's Car Industry

In view of historical factors and the constraints of the technological level at that time, China's research on artificial intelligence started slightly later than the world, traced back to the 1980s. During this period, a group of research institutions and technology companies in artificial intelligence emerged in China. However, due to the immaturity of the technology, China's artificial intelligence level made progress at a low speed at that time, and it was not until nearly a decade later that China's artificial intelligence showed a vigorous development trend. The research on intelligent vehicles in China started almost in sync with the research on artificial intelligence. It was in the 1980s that China began conducting research on autonomous vehicles. At present, the application of artificial intelligence in the automotive industry is mainly manifested in three aspects: intelligent driving, intelligent production, and intelligent after-sales service. Intelligent driving is one of the most vital applications of artificial intelligence in the automotive field, which refers to obtaining road condition information, obstacle information, etc. through various sensors and perception technologies, and utilising technologies such as deep learning and neural networks to make autonomous decisions and to control based on the obtained information. This technology has been widely applied in ar-

eas such as autonomous driving and advanced driving assistance. In the intelligent production process, artificial intelligence is more commonly used in the quality inspection of components, which can improve the stability, accuracy, and efficiency of car industry production.

In 2015, China proposed the "Made in China 2025" plan, with intelligent manufacturing continuously advancing under the government's promotion. Since 2015, hundreds of intelligent car companies have been established in the Chinese market. These car companies have incorporated artificial intelligence as a new factor in their production process, integrating new technologies such as 5G, cloud computing, big data, and industrial internet, and deeply diffusing AI technology into all aspects of intelligent car applications.

1.3 Introduction and Development History of BYD Company

BYD Co. Ltd. is one of the earliest car companies in China to enter the market for new energy and intelligent vehicles. The company has long held a leading position in car sales in China, adheres to independent research and development, and continuously promotes technological innovation. Therefore, this report selects BYD as a case study and analyses its application of artificial intelligence and its impact on enterprise development.

BYD Co. Ltd. was founded in February 1995 as a battery production company. Due to excessive competition in the battery market at that time, BYD began developing and producing vehicles in 2002. In 2005, BYD launched its brand's first car, the F3, officially entering the car industry. By 2015, this company's sales exceeded 100 billion yuan for the first time, becoming the third largest automaker in China. In the 2010s, artificial intelligence caused a stir in the Chinese car market, and BYD was also one of the earliest companies to enter the market to research intelligent vehicles. In April 2018, BYD launched the DiLink system, which is an intelligent networking system based on AI, speech recognition, car networking, and big data. In April 2020, BYD launched the DiPilot intelligent driving assistance system, which can achieve autonomous driving on highways and provide users with a safer and more convenient travel experience. In June 2022, BYD's market value exceeded 1 trillion yuan for the first time, ranking among the top three globally. As of March 2023, BYD has sold its cars in over 40 countries and established multiple production bases worldwide (Wen, 2022).

2 Research Methods

2.1 Case Study Method

This report takes BYD Automobile as the research object, studying its financial performance in the past five years. Combining the application history and landing points of company's intelligent manufacturing, this report compares and analyses the turning points of performance data curves, and analyses the effectiveness of its intelligent manufacturing technology research and application. Finally, the report proposes targeted optimisation suggestions.

2.2 Literature Review Method

Utilising a paper on the financial performance evaluation of BYD Auto based on an index model, a comprehensive evaluation system applicable to the automotive industry is constructed.
By comparing the results of this study with other data analyses, it validates the beneficial explorations of the company in the field of artificial intelligence and offers insights for evaluating the effectiveness of artificial intelligence applications in the automotive industry.

2.3 Combined Qualitative and Quantitative Analysis

Qualitative analysis is employed to study the developmental trajectory and current status of the manufacturing industry, as well as the overall situation of BYD Auto. Referencing performance evaluation literature, DEAP software is used to conduct quantitative calculations and qualitative analysis of relevant production and sales data.

2.4 Data Envelopment Analysis (DEA) Method

In the report, a DEA model is employed for both horizontal and vertical evaluations of BYD Auto's performance, providing a comprehensive analysis and comparative study of the company's artificial intelligence applications across static and dynamic dimensions.

3 Literature Review

3.1 Theoretical Framework

We use case analysis, literature research, qualitative analysis, and quantitative analysis. Combined method and data packet network analysis methods are used to analyse and explore the impact of artificial intelligence on BYD's development. In this paper, the analysis of existing literature has important reference value and research significance. The following is the summary and analysis of existing literature.

3.2 Introduction to the Existing Literature

3.2.1 Application Value of AI

In terms of application value, the research shows that the main artificial intelligence technologies in the current automobile manufacturing industry include computer vision, big data analysis, robot application, speech recognition and natural language processing, cloud computing, and virtual reality technology (Gao and Xing, 2021). The combination of these technologies can complete multiple tasks such as text extraction, information induction, data processing, and voice-to-text conversion, saving human resource costs. A noteworthy application of artificial intelligence is virtual reality technology, which is based on virtual and real environments, combined with a collection of cutting-edge technologies such as visual recognition, machine learning, and deep learning. Creating a virtual scene can improve the efficiency of product design and development, and at the same time provide support for the intelligent upgrade of the vehicle itself (ibid.). At the same time, the above research also specifically introduced the application of artificial intelligence technology in automobile manufacturing. The applications are mainly concentrated in the production lines, quality check, analysis and prediction, and warehousing and logistics. According to existing research, artificial intelligence has formed a complete application system in the field of automobile production and processing. In this system, with the increasing improvement of artificial intelligence technology in the future, the industrial structure of automobile manufacturing will be further optimised.

3.2.2 Performance Analysis of Artificial Intelligence in the Car Industry

Among scholars' research, there is an empirical study taking Changchun FAW Car Co. Ltd. as an example (Han and Shi, 2022). Judging from the data of FAW's total factor productivity from 2011 to 2019, it can be shown that the impact of artificial intelligence research and development on FAW Car Co., Ltd.'s earnings has been in a progressive stage since 2015, from comprehensive technical efficiency to pure technical efficiency. Looking at the average value of the scale benefit index, it shows that from 2011 to 2019, FAW Car Co., Ltd.'s input and output efficiency in technology and artificial intelligence research and development projects have further improved (ibid.). According to the analysis, in the automobile manufacturing industry, the higher the company's requirements for auto parts and overall quality and technical level, the less the use of direct labour, the greater the demand for high-tech talents, and the more artificial intelligence is used to replace labour. In this way, while improving labour productivity and saving labour costs, it can also improve production efficiency and increase company performance.

3.2.3 The Impact of Artificial Intelligence on the R&D Management Capabilities of Automobile Enterprises

Application analysis of BYD's financial performance evaluation based on DEA—analysis from a business perspective (Tan 2022), which shows that the automobile industry as a whole has developed towards a more concentrated trend in recent years, and auto companies with independent innovation capabilities and R&D capabilities have gradually occupied the market, while some of the market share of small and medium-sized manufacturers is slowly being eroded. At the same time, it can also show that BYD's overall technical level and management level are superior to those of the same industry; from the perspective of market segments, the data show that Chinese passenger car companies are paying more and more attention to the improvement of R&D capabilities and management capabilities (Liu, 2021). Continuously optimise production capacity, improve asset utilisation efficiency, and then bring about improvement in scale efficiency (ibid.).

3.3 The Main Problems Lying in the Current Study

Most of the existing research in the field of artificial intelligence and the car industry is to design and apply artificial intelligence machine vision, artificial intelligence deep learning, and artificial intelligence speech recognition technology

to the automobile industry, focusing on the design level. Research on the operating efficiency brought by artificial intelligence to the entire industry is nearly blank. Many studies fail to address the essential differences between AI and other technologies and the specific benefits that AI brings to the automotive industry. Although the existing research mentions that artificial intelligence has a positive impact on corporate performance, it does not continue to look forward to how artificial intelligence will serve the enterprise in the future, and how it will bring more profit and development space for the enterprise.
At the same time, in the field of new energy vehicles, most of the studies are still in the superficial imagination phase, without introducing how artificial intelligence technology specifically participates in the manufacture of new energy vehicles.

4 Analysis of Artificial Intelligence in BYD Co., Ltd

4.1 Specific Application Cases of Artificial Intelligence at BYD

4.1.1 Intelligent Power Retention

In BYD's "Super Hybrid System" or DMi series, the EHS Electric-Hybrid System is utilised. This system typically has two SOC (System-on-a-chip) settings modes, Intelligent Power Retention and Forced Power Retention, with Intelligent Power Retention being the application of artificial intelligence in the car industry. BYD DMi's Intelligent Power Retention system utilises technologies such as sensors, data analysis, and algorithms to adjust the operating mode based on road conditions and driving speed through real-time monitoring and analysis of grid data. The intelligent power protection system of the BYD DMi can automatically adjust the operating mode under different conditions, ensuring the engine operates at optimal efficiency through precise charging and discharging control. This can enhance battery durability and maintain battery safety performance.

4.1.2 Advanced Driving Assistance System

In the "Tang DM" model by BYD, an ADAS (Advanced Driving Assistance System) intelligent driving assistance system is applied. It utilises artificial intelligence sensors and computer technology to monitor the driving environment and driver's behaviours in real-time, providing comprehensive safety assistance and featuring an advanced perception system that detects road conditions through image scanning technology and presents the information to the driver (Yang et al,

2019). The BYD ADAS system includes features such as forward collision warning, blind spot monitoring, and automatic parking assistance (Yu, 2019). In the new ”DiPilot” advanced driving assistance system launched by BYD in 2023, a unique algorithm called ”DiTrainer” has been developed. This mode utilises artificial intelligence's analysis and integration capabilities on big data to analyse user behaviour patterns and provide targeted guidance and suggestions.

4.1.3 Intelligent Network System

BYD's latest release, DiLink 4.0, is an intelligent network system developed independently based on technologies such as artificial intelligence, the internet, and big data. It can provide interconnection between people and vehicles, as well as between vehicles. The DiLink system has precise voice recognition capabilities, and the voice interaction function can be activated by custom wake words, enabling information exchange and feedback.

4.2 BYD Efficiency Analysis

In order to study BYD's financial situation from 2018 to 2022, we analysed the data for profitability, sales, and efficiency.
In terms of sales, we analysed BYD's sales volume, market share, and sales ranking.

Years	Sales	Market Share	Sales Ranking
2018	500028	2%	18
2019	441807	2%	20
2020	404279	2%	20
2021	721349	3%	12
2022	1843553	8%	1

Table 1: BYD's sales, market share, and sales ranking from 2018 to 2022 (CAAM 2022).

From 2018 to 2022, BYD's market share increased year by year, and the sales ranking as a whole also showed an increase.
In terms of efficiency, we conducted a comprehensive calculation of BYD's efficiency during 2018-2022 through DEA.

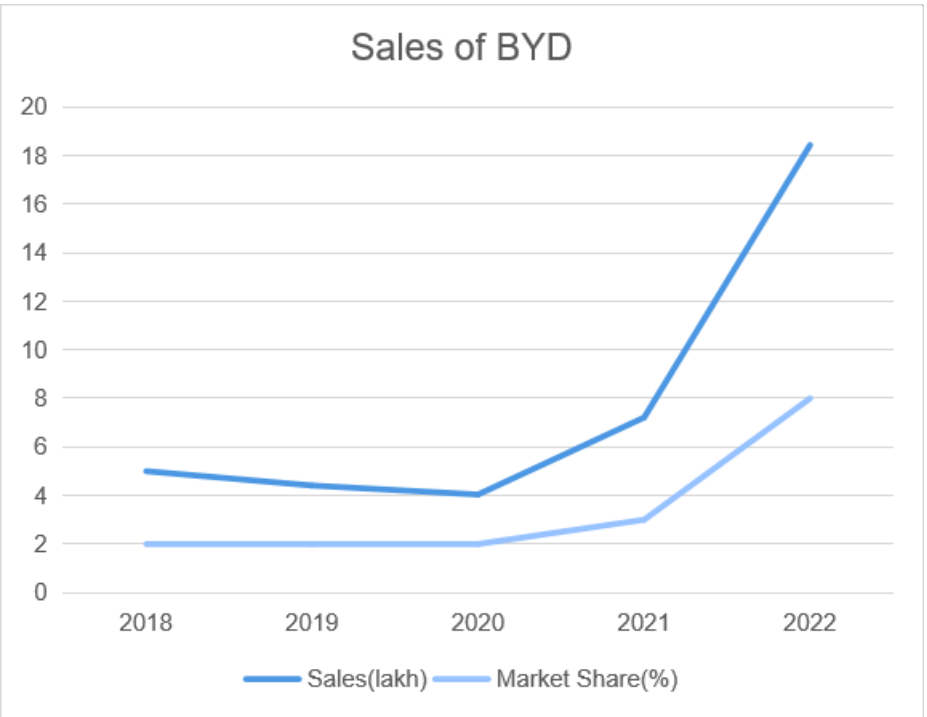

Figure 1: BYD's sales and market share from 2018 to 2022

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DEA (data envelopment analysis) is a method to evaluate the output and input of multiple indexes and measure the effectiveness of a system. Various indices are divided into output and input, and the relationship between output and input is considered to calculate enterprise efficiency without setting the weight in advance. Therefore, in this study, we selected total operating income and net profit as output, expenses and the number of personnel of artificial intelligence as input, and adopted the DEA method to analyse the overall efficiency, pure technical efficiency, and scale efficiency of BYD and study the impact of BYD's AI development on efficiency in the past five years.

From Table 1, we can see that from 2018 to 2022, BYD's AI expenses and the number of AI personnel have risen. The total operating income also showed an increasing trend. Although non-net profit has declined from 2018 to 2019 and 2020 to 2021, the overall trend is still rising. After DEA analysis, we can see that during 2018-2022, BYD's technical efficiency remains at 1. Overall efficiency

	Output		Input	
Years	**Total Operating Income**	**Net Profit**	**AI Expenses**	**The Number of AI personnel**
2018	2.98E+11	5.86E+8	1.53E+9	1276
2019	3.14E+11	2.31E+8	1.27E+9	1384
2020	3.42E+11	2.95E+9	1.76E+9	1372
2021	4.93E+11	1.26E+9	1.87E+9	1590
2022	9.09E+11	1.56E+10	3.53E+9	3128

Table 2: BYD's output and input from 2018 to 2022 (BYD 2022).

Period	**CRSTE**	**VRSTE**	**SCALE**	
2018	0.753	1.000	0.753	irs
2019	0.938	1.000	0.938	irs
2020	0.826	1.000	0.826	irs
2021	1.000	1.000	1.000	-
2022	1.000	1.000	1.000	-

Table 3: DEA analysis result

and scale efficiency both show a growing trend and reach 1 in 2021. And the return to scale also has kept increasing in 2018-2020.
These data show that BYD's profits, sales, and efficiency have increased while the level of research, development, and application of artificial intelligence has gradually risen.

5 Contributions & Limitations

The original intention of this report was to employ model analysis to validate the relevant hypotheses concerning the impact of artificial intelligence on the automotive manufacturing industry. Depending on our current research, we could get the result that AI indeed has a positive impact on the BYD company. However, due to the relatively short period of practical application of artificial intelligence, spanning from the clear onset of the "Year of Artificial Intelligence" in 2015 to the years 2021 and 2022, which were influenced by the pandemic, the supporting data for hypothesis validation is limited. Given the multitude of factors affecting enterprise operations, including not only artificial intelligence and automation applications

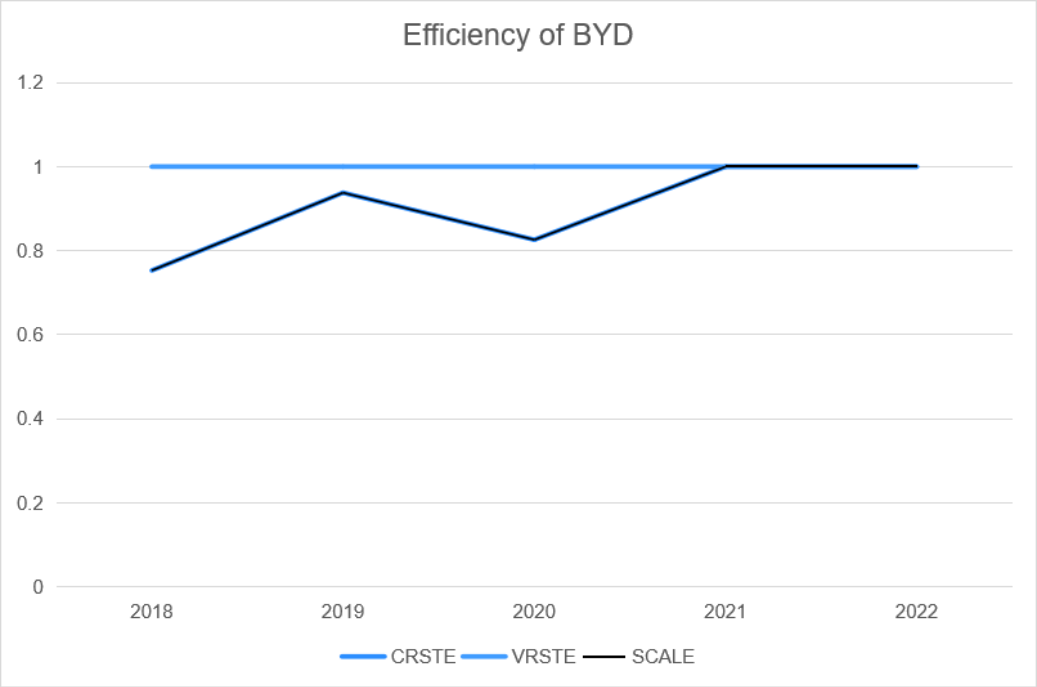

Figure 2: Efficiency of BYD from 2018 to 2022

but also market demand, cost management, innovation and research and development investments, supply chain efficiency, marketing strategies, international trade fluctuations, and environmental requirements, these factors are intertwined and collectively influence the financial performance of automotive manufacturing companies. We lack sufficient evidence to exaggerate the impact and effectiveness of artificial intelligence on the automotive manufacturing industry. Therefore, the soundness of the model analysis itself carries certain limitations and can merely offer enterprises some reference value, aiding in assessing the reasonableness of adjustments to financial expenditures.

Author Contributions

Conceptualisation: Dai, Liu, Li; Methodology: Cheng, Liu, Dai; Validation and formal analysis: Liu; Investigation, resources, data curation: Dai, Liu, Lin, Li, Cheng; Writing-original draft preparation: Dai, Li, Lin, Cheng; Visualisation: Liu,

Cheng, Dai; Writing-reviewing and editing and supervision: Dai. All authors have read and agreed to the published version of the manuscript.

Division of Roles & Responsibilities

In the early stage, all members collected data and read literature together, while in the later writing stage, the division of labour was as follows:

DAI LE: Leader & Project Overview & Project Background
CHENG YULIN: Research Method & Conclusion
LI LUFEI: Literature Review
LIN YUEHAN: Specific Application Cases of Artistic Intelligence by BYD Co., Ltd
LIU YANAN: BYD Efficiency Analysis.

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Research Guideline

This study followed the research guidelines of the PPE (Philosophy, Politics, and Economics), Cambridge Academic Program 2023.

Informed Consent Statement

Not Applicable.

Data Availability

Please contact the corresponding author for all reasonable requests for access to the data.

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Conflicts of Interest

The authors declare no conflict of interest.

Intellectual Property

The authors attest that copyright belongs to them, the article has not been published elsewhere, and there is no infringement of any intellectual property rights as far as they are aware.

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