

Research on the Impact of Digital Transformation on the Operational Performance of Contemporary Amperex Technology Co. Limited

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Abstract: In the context of the accelerated development of the global digital economy, digital transformation has become the core driving force for enterprises to improve their business performance. This paper takes Contemporary Amperex Technology Co. Limited (CATL), a leading enterprise in the power battery industry, as an example, and systematically analyzes its digital transformation path and its impact on business performance. The study shows that CATL has significantly optimized production processes and management efficiency, reduced operating costs, and enhanced product innovation capabilities and market competitiveness through a phased digital transformation strategy, including system upgrades, Internet of Everything, data empowerment, and AI assistance. In addition, digital transformation has strengthened its global industry leadership position by strengthening supply chain management and expanding into international markets. This study provides theoretical and practical enlightenment for manufacturing enterprises to achieve high-quality development through digitalization, emphasizing the need to promote transformation in stages based on enterprise capabilities, and focusing on technological innovation and ecological synergy.

1 INTRODUCTION

In the context of a new round of global scientific and technological revolution and industrial transformation, digital transformation is reshaping the competitive landscape and value creation model of enterprises. Digital transformation is a systematic change in which enterprises reshape business processes and reconstruct value systems through the integration of digital tools and intelligent technologies, and it is the operation of enterprises to apply a new generation of information and communication technology to various fields of business. Digital transformation is a comprehensive project, and transformation covers multiple levels and a wide range of dimensions (Yan, 2024). Through digital transformation, enterprises can capture market demand in real time, optimize business structure, and improve resource allocation efficiency. This transformation not only improves the information integration ability of enterprises, but also realizes efficient innovation through Internet analysis, and builds sustainable competitive barriers in the era of digital economy. China's 14th Five-Year Plan clearly

puts forward the strategic orientation of "promoting the deep integration of digital technology and the real economy", and the digital transformation of enterprises has changed from an "optional" to a "must-have" for survival and development. As a core player in the global new energy industry chain, Contemporary Amperex Technology Co. Limited (CATL) has ranked first in the global market share of power batteries for six consecutive years (37% in 2023) with the digital transformation path of "system upgrade, Internet of Everything, data empowerment, and AI assistance", and its development trajectory provides a valuable research sample for exploring the digital transformation of the new energy manufacturing industry.

By building the world's first benchmark factory for battery intelligent manufacturing (lighthouse factory) and building a full-life cycle digital platform covering R&D, production and recycling, CATL achieved a countercyclical myth of a 9.3% drop in revenue and a 17% increase in net profit during the price war in the new energy industry. In the context of digital transformation, this paper combines the development of CATL, extracts the underlying logic

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and practical experience of CATL's digital transformation through the study of its digital evolution path, and studies the impact of the value created by digital transformation on the business performance of enterprises, which is of great practical significance for promoting the high-quality development of the new energy industry and accelerating the process of new industrialization.

2 THE MOTIVATION AND PROCESS OF CATL'S DIGITAL TRANSFORMATION

2.1 Overview of the New Energy Battery Industry

In the context of global energy transition, the new energy battery industry has become the core track to support the development of green economy. As an emerging industry, the new energy vehicle industry has entered a period of rapid growth in line with the development goals of low-carbon emission reduction in the new era (Hu, 2024). According to a report by the International Energy Agency (IEA), global electric vehicle sales are expected to reach 40 million units by 2030, which will greatly boost battery demand. The Ministry of Industry and Information Technology of the People's Republic of China, the National Development and Reform Commission, the Ministry of Science and Technology, and the Ministry of Finance jointly issued the Action Plan for Promoting the Development of the Automotive Power Battery Industry, aiming to accelerate the development ability and level of China's automotive power battery industry and promote the healthy and sustainable development of the new energy battery industry.

At present, the iteration of new energy battery technology has achieved breakthroughs in many aspects, such as the mass production of high-nickel ternary cathode materials with a monomer energy density of 300Wh/kg; CTP/CTC integrated technology improves system energy efficiency by 15%; The solid-state battery has completed the laboratory stage verification and is expected to enter the mass production stage in the next 2-3 years. Sodium-ion batteries have started the industrialization process with resource advantages, and initially built low-cost energy storage solutions.

2.2 Introduction to CATL

CATL is the world's leading supplier of new energy batteries, founded in December 2011 in Ningde,

Fujian Province, mainly engaged in the R&D and manufacturing of power batteries and energy storage systems. In 2018, CATL successfully completed an initial public offering of A-shares and listed on the Shenzhen Stock Exchange (Gu, 2024). Since 2019, CATL has been shortlisted as a "Lighthouse Factory" by the World Economic Forum three times (Zhang and Zhai, 2024). The company has been the global champion in power battery loading for six consecutive years, with a market share of more than 35% in 2023, and its customers include Tesla, BMW, Mercedes-Benz and other international car companies. Its self-developed CTP3.0 technology, sodium-ion batteries and Kirin batteries and other innovative products have promoted the energy density of the battery system to exceed 250Wh/kg. By the end of 2023, CATL has deployed 13 production bases around the world, with an annual production capacity of over 400GWh, and has built a closed-loop industrial chain for lithium resource development and battery recycling. The company's R&D investment accounts for more than 20 billion yuan, holds more than 10,000 patents, and leads the formulation of a number of international standards, providing core technical support for the global energy transition.

2.3 CATL's Digital Transformation Drivers

In terms of green development and the promotion of carbon peaking and carbon neutrality, digitalization has become the key path to achieve green innovation due to the current social situation of "carbon peak and carbon neutrality". With the release of the dual carbon policy, CATL, which is in the process of laying out its digital transformation strategy, has continuously deepened its digitalization process, reducing energy consumption and optimizing resource utilization through intelligent production (Xia, 2024).

From the perspective of industry competition and market demand, the 2012 "Energy-saving and New Energy Vehicle Industry Development Plan" promoted the outbreak of the domestic new energy vehicle market, and in the face of competition from international competitors such as Panasonic and LG, CATL, as a core supplier, needs to consolidate its technological advantages through digital transformation. In addition, after cooperating with car companies such as BMW Brilliance, CATL's order volume has surged, and it urgently needs digital means to meet the challenges of large-scale production and improve production capacity and efficiency.

In terms of production and equipment collaboration requirements, because power batteries are discrete manufacturing, the production process involves multiple links, long processes and high standardization difficulties, so it is difficult for the traditional management mode to meet the requirements of high-precision quality inspection. For example, with a large amount of data on a single battery and low detection efficiency, enterprises urgently need to optimize the production process and reduce the defect rate through technologies such as the Internet of Things and big data. In addition, after CATL introduced automation equipment in the early days, it faced the problem of insufficient compatibility between equipment, and needed to realize the whole process through a unified platform (such as MES system) to improve production efficiency.

From the perspective of the needs of strategic transformation, digital transformation aims to shift from "scale expansion" to "quality growth", and build core competitiveness through technology empowerment. CATL uses the "cloud-edge-end" AI defect detection technology to reduce the defect rate and significantly improve product reliability.

2.4 CATL's Digital Transformation Process

As a leading enterprise in the global power battery industry, CATL's digital transformation process is a model for upgrading traditional manufacturing to intelligent manufacturing. Its transformation process can be divided into four key stages, and gradually realized the leap from "manufacturing" to "intelligent manufacturing".

2.4.1 System Upgrade stage: Build a Digital Management Base

In 2014, CATL launched an in-depth cooperation with SAP, a global enterprise management software giant, to officially launch its digital transformation. Through the introduction of core systems such as enterprise resource planning (ERP), supplier relationship management (SRM) and customer relationship management (CRM), the company has built an integrated information management platform with ERP as the core, covering three levels: core business, business support and functional management (Wang, 2022). This system realizes the standardization and efficient collaboration of business processes, such as order management, supply chain collaboration and comprehensive

informatization of financial accounting. The application of the SAP system not only improves the efficiency of internal operations, but also lays the foundation for subsequent data-driven decision-making. At this stage, CATL integrated the upstream and downstream resources of the industrial chain through the ERP system, promoted the overall digitalization process of the industry, optimized the procurement process through data exchange with suppliers, and enhanced the customer demand response capability through the CRM system.

2.4.2 Internet of Everything Stage: The Internet of Things Empowers the Whole Production Process

In 2015, CATL ranked third in the world in terms of installed power battery capacity, and began to comprehensively promote the application of Internet of Things (IoT) technology. In this stage, millions of IoT terminal devices are deployed to cover more than 3,600 quality inspection points, and production data is collected in real time and transmitted to the central control system to achieve accurate control of the entire production process. At the same time, the Manufacturing Execution System (MES) was introduced to integrate elements such as production planning, equipment status, and energy consumption, such as real-time monitoring of equipment failures and early warnings to reduce downtime. In addition, through PLM software, CATL has achieved comprehensive and accurate control of product design data, process data, manufacturing data, etc. shortening the product iteration cycle and improving market response speed (Wu, 2024). The technological breakthrough at this stage has significantly improved production efficiency and provided technical support for the expansion of the global market.

2.4.3 Data Empowerment Stage: Big Data Drives Decision Optimization

In 2017, CATL's installed power battery capacity surpassed Panasonic and became the world's first. With the explosion of data volumes, the company began to build a comprehensive big data platform and worked with many enterprises to solve the bottleneck problem of data storage and analysis. By cooperating with e Cloud to build an IoT data analysis platform, it opens up the data channel between remote and local data centers to achieve secure data transmission and real-time analysis; At the same time, it cooperated with Intel to upgrade the MES system and use high-performance processor technology to increase the processing power by 50%, supporting the expansion

of production capacity under the surge in market demand. At this stage, the company was able to reduce the product defect rate by 15% by analyzing production data to optimize the process, such as predicting equipment failures and adjusting production parameters. This transformation marks CATL's shift from "experience-driven" to "data-driven", laying the data foundation for smart manufacturing.

2.4.4 AI-Assisted Stage: Intelligent Production is Fully Implemented

After being rated as an "Intelligent Manufacturing Benchmarking Enterprise" by the Ministry of Industry and Information Technology in 2019, CATL began to apply artificial intelligence technology on a large scale. In the field of quality control, CATL worked with Intel to develop an AI battery defect detection solution, combining computer vision and deep learning technology to improve the accuracy of defect detection to 99.9%; In terms of production optimization, machine learning algorithms were introduced to adjust parameters in real time to predict equipment maintenance needs to reduce unplanned downtime by 20%; At the same time, AGV unmanned transport vehicles and intelligent warehousing systems are deployed to increase inventory turnover by 40% and reduce logistics costs by 25%. As of 2024, among the company's 13 production bases around the world, the German plant has obtained Volkswagen battery cell certification with its intelligent production line, and its overseas market share has exceeded 32.7%. At present, CATL is deepening the layout of AI and data platforms through the establishment of Times Qiji Technology, and continues to lead the intelligent upgrading of the new energy industry.

3 THE IMPACT OF CATL'S DIGITAL TRANSFORMATION ON BUSINESS PERFORMANCE

3.1 Digital Transformation Promotes Technology R&D and Profitability Improvement

As shown in Figure 1, CATL has continued to increase R&D investment since 2015, with R&D expenses of nearly 8.6 billion yuan in the first half of 2024 and a cumulative number of more than 36,000 patents. The high R&D investment has been

translated into technological advantages, such as the Shenxing Plus battery (the world's first lithium iron phosphate battery with a range of 1000km and 4C supercharging) and Kirin high-power batteries, which will be launched in 2024, which have significantly improved the competitiveness of products. CATL's technological advantages are directly reflected in the gross profit margin: the gross profit margin reached 31.17% in the third quarter of 2024, an increase of 4.53 percentage points quarter-on-quarter. This highlights the profitability of technology R&D brought about by digital transformation.

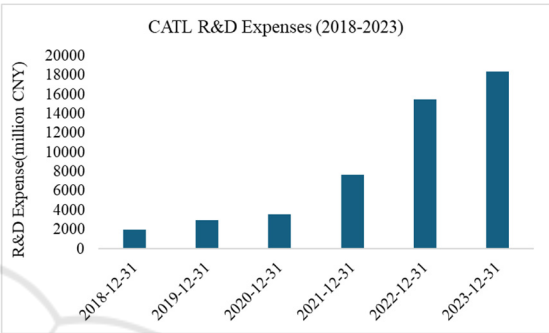


Figure 1: CATL R&D expenses from 2018 to 2023 (Photo credit: Original).

Although the revenue in 2024 is expected to decline by 8.71%-11.2% year-on-year due to product price adjustment due to the decline in lithium carbonate prices, through cost optimization, product upgrades and market share expansion, the double growth of gross profit and net profit as shown in Figure 2 has been achieved, and net profit is expected to increase by 11.06%-20.12% against the trend to reach 49 billion to 53 billion yuan (Global Network, 2025).

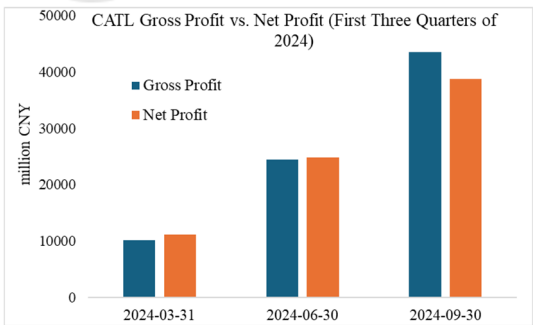


Figure 2: CATL gross profit vs. net profit (first three quarters of 2024) (Photo credit: Original).

3.2 Digital Transformation Optimizes Costs and Operational Efficiency

Through intelligent production and supply chain management, CATL has achieved cost reduction and efficiency increase. For example, as shown in Figure 3, the operating cash flow in the first three quarters of 2024 reached 66.977 billion yuan, the net profit was 36.001 billion yuan, a year-on-year increase of 15.59%, and the ratio of free cash flow to revenue was 5.43% on average, showing the optimization effect of digital transformation on cash flow. In addition, the company will integrate its global production capacity layout through a digital platform, add a new joint venture plant in Spain in Europe in 2024, and deepen cooperation with Stellantis and other car companies, driving the proportion of overseas revenue to increase to more than 35%. The high gross margin in overseas markets (about 5 percentage points higher than that in the domestic market in the first half of 2024) further supported the overall profitability.

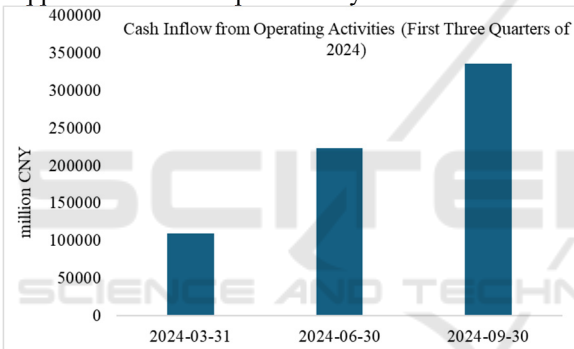


Figure 3: Cash inflow from operating activities (first three quarters of 2024) (Photo credit: Original).

3.3 Digital Transformation Consolidates the Market Competitiveness and Share of Enterprises

Digital transformation has helped CATL stay ahead of the fierce competition. In 2024, its domestic power battery market share will reach 45.08%, an increase of 1.89 percentage points year-on-year, and the shipment of energy storage batteries will rank first in the world for three consecutive years. Through the Lithium Resource Service (LRS) authorization model and battery chassis integration (CTC) technology, the company not only reduces its dependence on upstream resources, but also expands the energy storage and commercial vehicle markets, and in 2024, the commercial vehicle brand "Tianxing" will cover the logistics and public transportation fields, further

expanding the application scenarios. In addition, digitally-driven customer collaboration, such as battery swap cooperation with FAW and SAIC, strengthened customer stickiness, driving the installed volume to increase by 28.6% year-on-year to 246.01GWh (Electric Zhijia, 2025).

3.4 Digital Transformation Promotes Enterprise Risk Resilience and Long-Term Growth Potential

In the face of cyclical fluctuations in the industry (such as lithium carbonate price fluctuations in 2023 and 2024), CATL optimized inventory management and procurement strategies through digital forecasting models, and provided for impairment losses of RMB7.543 billion in Q3 2024 to divest inefficient assets (Sina Finance, 2024), while improving capacity utilization and reducing unit depreciation costs. In the long run, the company's integrated ecology of "photovoltaic storage, charging and swapping" and overseas energy storage projects (such as the RTC project in the United Arab Emirates) will benefit from the global energy transition, and the net profit is expected to exceed 60 billion yuan in 2025.

4 CONCLUSIONS

This study finds that CATL is evolving from a "battery manufacturer" to a "new energy solution service provider" by continuously deepening its digital transformation, and its transformation path provides a replicable Chinese solution for the digitalization of the global manufacturing industry. CATL's digital transformation is the result of policy dividends, market expansion, technological bottleneck breakthroughs, and internal efficiency demands, laying the cornerstone for CATL to realize the leap from "manufacturing" to "intelligent manufacturing". With technology research and development as the core, the digital transformation has realized the transformation from "scale expansion" to "quality growth" through intelligent production, global layout and ecological chain integration. Although short-term revenue fluctuates due to the impact of raw material prices, net profit continued to grow, gross profit margin increased and market share was stable, confirming the far-reaching impact of digital transformation on CATL's operating performance. This study can provide guidance for

China's related industries to break through the transformation dilemma.

Since this study does not conduct a specific empirical analysis, it does not identify the specific reasons that contributed to CATL's digital transformation and improved business performance. In the future, relevant variables can be found for further refinement, so as to facilitate in-depth research on this topic.

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